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COTTON SPINNING

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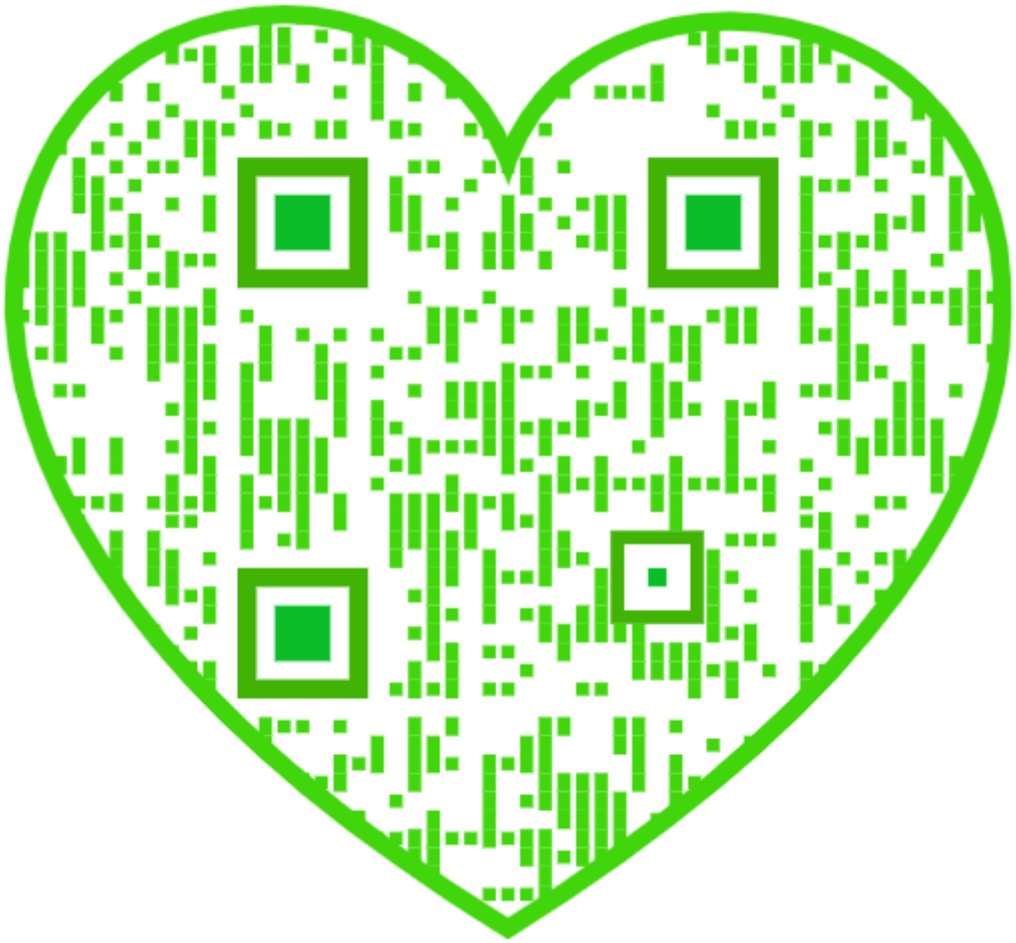

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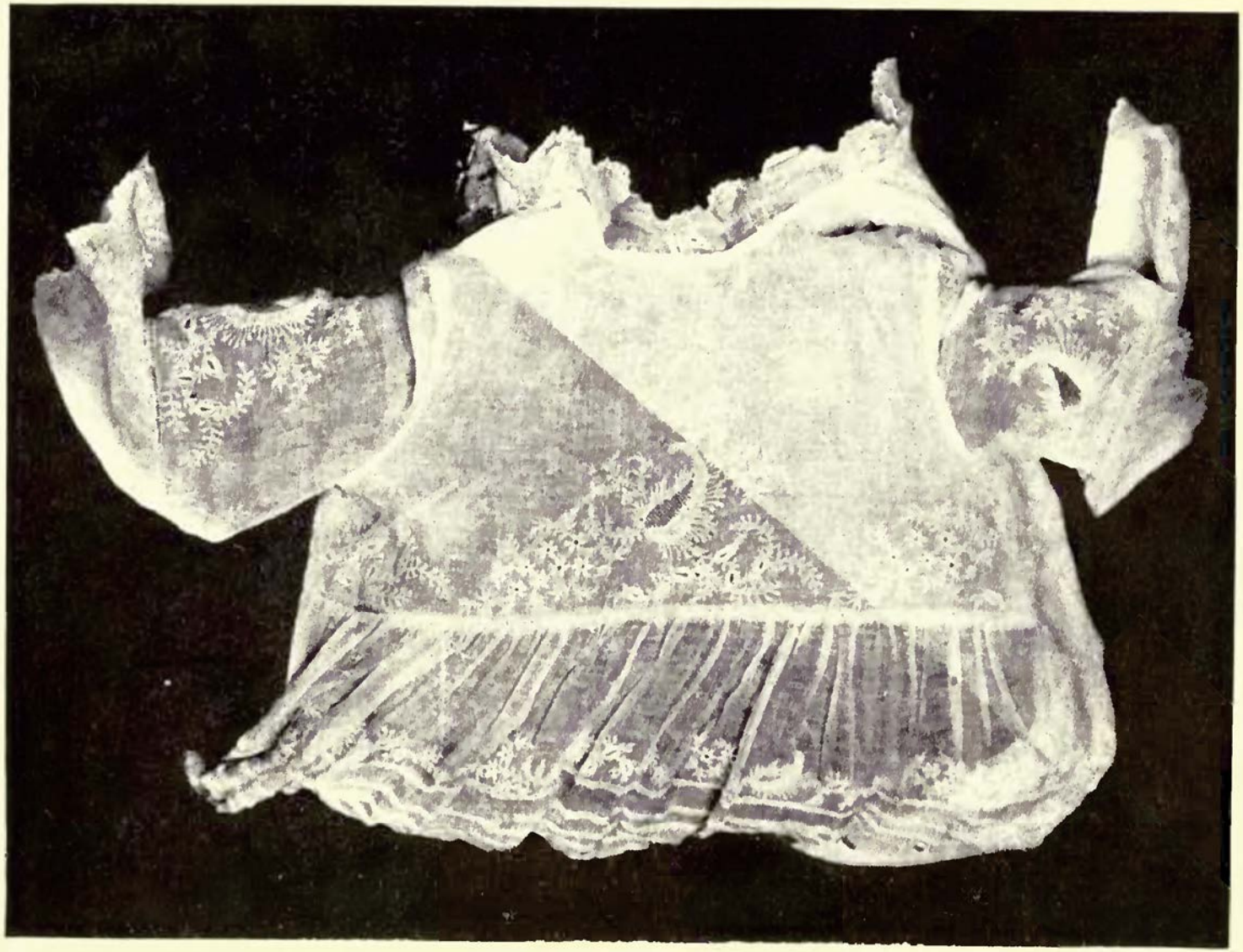

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This frock (90 years old) is of cotton, spun, woven and embroidered by hand.

(*See page* 54)

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COTTON SPINNING

BY

A. S. WADE

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FOREWORD

For the past thirty-five years I have taken the deepest interest in educational work connected with the cotton industry, feeling that a widespread knowledge of its activities must be of advantage to the public. A generation has passed since, as Managing Partner in a well-known firm of cotton spinners, manufacturers and merchants, I began the issue of brochures and books in which the different manufacturing processes of cotton and other textiles were described in a non-technical way. A keen public interest led to a great demand for these books, which showed that the manufacturing processes in an industry could, by popular treatment, be made not only instructive but interesting to the general reader.

This educational work I supplemented by extensive propaganda when I became associated with the national and international organisations of the great cotton industry. During the twenty-one years I was President of the English Federation of Master Cotton Spinners, embracing fourteen Associations, and during the eleven years in which I was President of the International Cotton Federation, I took the initiative in giving to the world through the public Press, through annual reports and periodical reviews, all possible information about this industry, which was and is the life blood of Great Britain's Export Trade. In recent months I have also used the cinematograph as a means of conveying to the public a knowledge of the intricacies of cotton spinning and weaving, and views of machinery in motion have been exhibited to many millions of people in all parts of

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the world, illustrating the various processes through which cotton passes from the breaking of the bale to the completion of the finished fabric.

In all the publications the purely technical aspects of the industry were not dealt with, except where essential, there being at all times a full supply of technical works on cotton subjects for those engaged in carrying on the industry. My aim was and is to present views of a great industry in such a way as to bring home to the general reader the preponderating position amongst the manufacturing nations of the world held by the British Cotton Industry, and at the same time to describe the industry as a whole in a way that does not come within the scope of a treatise of a technical character.

The volume, written by Mr. A. S. Wade, deals with this wider view of the cotton industry. In his interesting survey he very rightly does not forget either the romance, the vastness, or the intricacy of his subject. It is a book which should be read widely, for it seems to me to fill a gap in cotton industry literature and contains the most recently published statistics. My hope is that other industries, through this valuable series of books, may be treated with equal efficiency.

CHARLES W. MACARA.

MANCHESTER, 1921

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INTRODUCTION.

A CELEBRATED author some years ago achieved the well-nigh impossible by telling us all about municipal finance without the boredom of a single row of figures. His aim is one to be emulated by all writers who seek to treat of subjects the interest of which is limited, unless there is added to it something in the treatment itself which will evoke the co-operation of the reader's mind. Our propagandists during the war and the subsequent period of reconstruction have struggled hard to capture the secret, and one finds, too, in popular works on abstruse subjects, even on psycho-analysis, a growing tendency to accommodate one's words to the reluctancy of the ear of the ordinary man where scientific affairs are concerned. This little book on cotton spinning has been written with the feeling that the subject is not without very strong intrinsic interest, but that it is an interest which must be communicated if the readers have no personal relation with the industry. Cotton spinning is not everybody's affair. Some people will read of it because they spend their days either actually in the mill or else in the county where it is best known. Some will read because of a general interest in industry as a whole. How to make what one has to say about it appeal to people who are outside these classes is the problem which a writer aiming at securing the interest of non-technical readers has to put before his eyes. From these words it will be guessed that this book is not so much meant to give technical instruction—indeed it may at once be said that that is no part of its aim—as to take a wide view over the cotton spinning world and to communicate the results of one's vision in a form which will appeal to the elusive support of the general reader

The field over which one's vision roams is indeed a vast one. Apart from agriculture, which, being the industry by which we live, must always stand first, no industry is so important to the two great English speaking nations as that of cotton. To the United States it is, of course, primarily part of its agricultural industry, a great part, too, inasmuch as only of one article—maize—does that country produce a larger crop. Beyond its importance so viewed, cotton, purely as a manufacturing industry, has a high place in the United States' activities, though in this sort of importance it is of greater concern with us. In both countries it is, furthermore, a great factor in the banking, land and sea transport, warehousing and marketing. In both it is a great export industry. Of all the bonds between the United States and our own nation, cotton has proved the strongest. Our links with the great spirit of Abraham Lincoln were made closer and more truly associative by the strands uniting the cotton interests of the two countries. So on the continent of Europe cotton has proved a basis of conciliation, co-operation and joint effort between the peoples. And when the League of Nations is given definite shape and being it may build part of its edifice of peace upon the spirit which has long been shown in the give and take that has distinguished the international relations of this great industry.

That glance over the whole field shows what fascinating paths of inquiry there are to be followed ; and the difficulty will be to keep only to the corner which is devoted to the spinning section of the industry. This corner, however, is extensive in itself, and, where we depart from it—as for instance in the chapter devoted to the raw material question—it is only to explore allied territory which has immediate contact with it.

The greatest problem of the future to the cotton spinner is whether his raw material will be assured, and consequently the question has a prescriptive right to discussion in a book dealing with his trade. Other interesting issues have had to be ruthlessly excluded herefrom ; and it is perhaps well that the point of view of the author should be at once clearly stated, as a means of assisting the reader. First, then, the aim has been to be thoroughly up to date, which means that every effort has been made to ascertain the true position as to cotton spinning since the war. Secondly, comprehensiveness has been striven after ; so that something like a true perspective of this international industry may be obtained. Thirdly, a restatement of the growth of the art of spinning, with, it is hoped, some new considerations and speculations, has been deemed of special interest in view of the increased alertness to industrial matters in the public mind of to-day. Of cotton spinning as a modern operation an outline will be found in another book in this series, that entitled *Cotton* by Mr. R. J. Peake. Here it is treated as an industry on the lines suggested above.

The author acknowledges indebtedness to a very large number of authoritative writers. For the historical sketch he consulted all well known writers on the cotton industry, French, Espinasse, Kennedy, Mortimer, etc., and the articles in encyclopaedias. For the modern sections of the books he has gone to the reports of various Governments, and in this connection should, in particular, gratefully acknowledge the help he has received from Sir Charles W. Macara, Bart., past president of both the International Federation of Master Cotton Spinners and Manufacturers' Associations and of the English Federation of Master Cotton Spinners' Associations.

COTTON SPINNING

CHAPTER I

THE WORLD'S SPINDLES

ACCORDING to a comprehensive and valuable return issued by the International Cotton Federation at the end of the year 1920, the number of active cotton spindles in the various countries of the world was as follows—

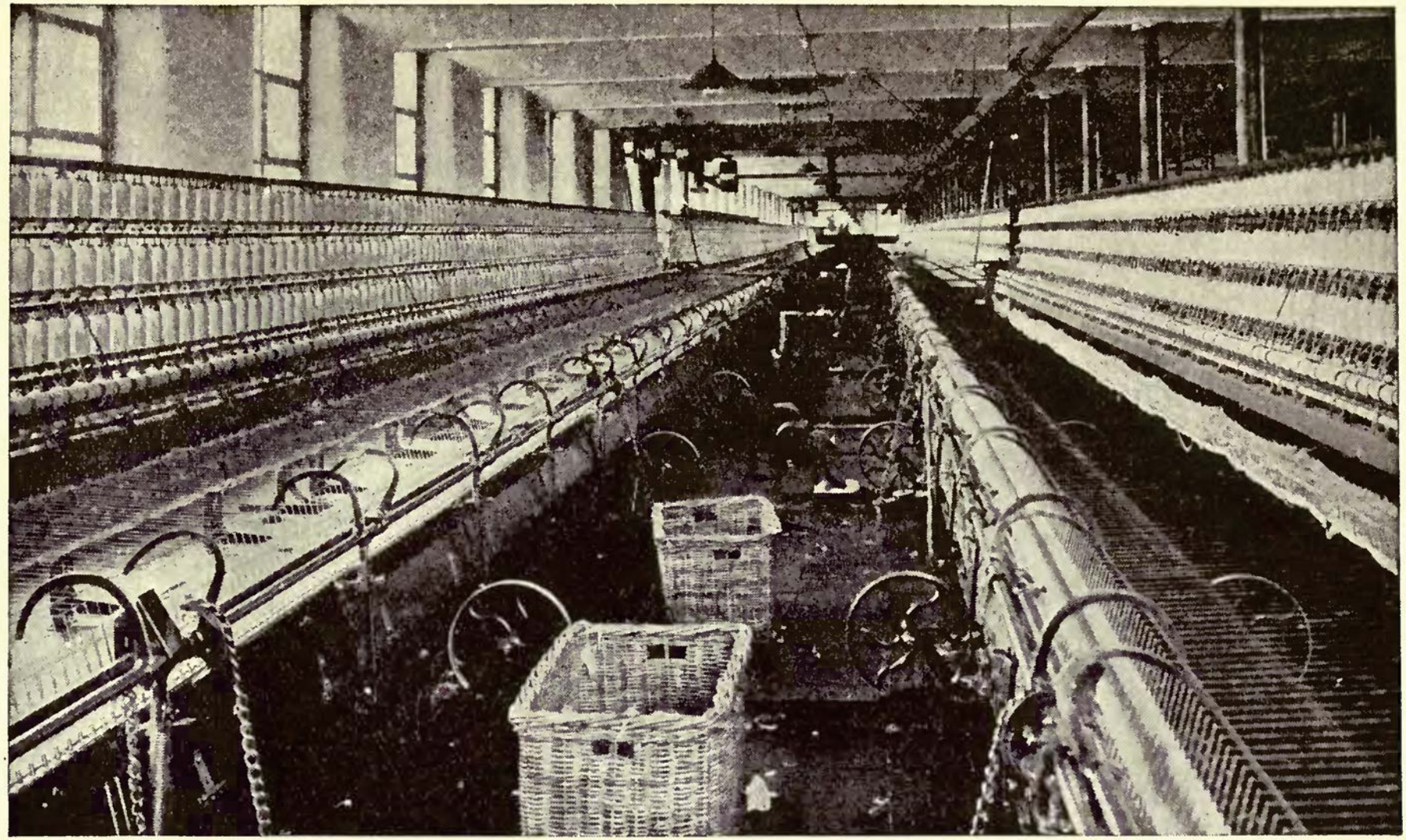
Great Britain	58,692,410
France	9,400,000
Germany	9,400,000
Italy	4,514,800
Czecho-Slovakia	3,584,420
Spain	1,800,000
Belgium	1,572,000
Switzerland	1,536,074
Poland	1,400,000
Sweden	670,350
Holland	597,942
Portugal	482,000
Finland	239,828
Denmark	116,644
Norway	72,724
India	6,689,680
Japan	3,690,090
China	1,600,000
United States	35,872,000
Canada	1,200,000
Mexico	720,000
Brazil	1,600,000
Total	145,540,962

These figures represent the productive spindles, but it must be borne in mind that the proportion of them

which are active vary according to the state of the trade and according to commissions for repair. It is interesting to dissect these figures a little more closely, since the grouping together of all spindles—mule and ring—may rather hide from the reader the significant differences which exist between them and in their distribution.

In the history of the spindle nothing is more striking or interesting than the way in which development has all along followed parallel lines, which at present terminate in the mule and the ring spinning machinery. Mule and ring represent two methods of spinning, the former being characterised by a certain intermittency of action, the latter being continuous. The distinction and its meaning is dealt with later ; here it need only be mentioned with a view to fixing it in the reader's mind.

One of the great differences between the cotton spinning industry of England and that of other countries, is that ours is principally mule and the rest of the world's principally ring. The latest census of spindles shows a total of 53,393,679 mule spindles actively employed, of which Great Britain owns 39,391,318. Of ring spindles, we have 10,654,584 out of a world total of 66,263,910. Considering the obverse side of these figures, we see that the rest of the world has 14,002,361 mule spindles and 55,600,000 ring spindles. This gives us two and three-quarter times as many mule spindles as the rest of the world ; while other cotton-spinning countries have six and a half times as many ring spindles as we have. Those statistics are significant of an equally striking difference in the kind of spinning done here and in other countries. England's cotton industry tends ever to go finer and finer. Miracles of fineness have been achieved in some of our



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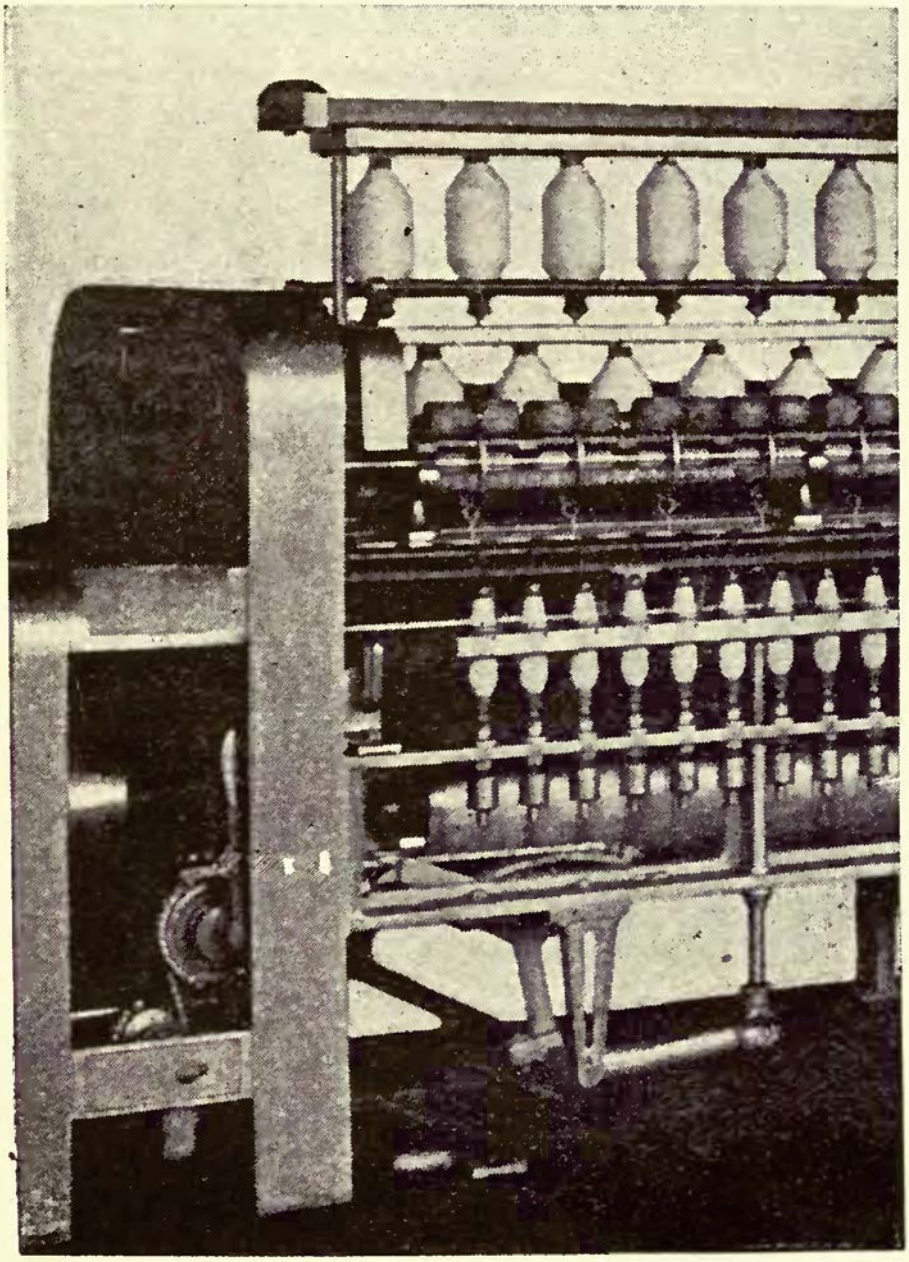
A MODERN MULE SPINNING ROOM.

yarns, during the course of experiments, both in the testing of machinery and of possibilities of the finer cottons. These achievements, however, are mainly interesting to the technical observer. On the other hand, however, there has been, side by side with these technical experiments, an actual production of finer yarns for commercial purposes, leading to the manufacture of cotton fabrics which appear to have all the delicacy of texture and beauty of finish of silk. In this province of fine spinning, the mule is by far the better machine. Its supremacy in spinning the higher and finer qualities of yarns is the reason for its preponderance in this country. Comparatively, the spinning of other countries is, in bulk, coarse, and hence, of course, the preponderance of the ring-frame among them.

The mule is much the more complicated machine. Its operation calls for a greater degree of skill, and hence, in many cases where it has been adopted abroad, there has been need for British operatives to go to give instruction as to its working. Certain implications of the preponderance of fine spinning in this country should be borne in mind, since they have great relevance to the periodical scares which run their course in the sensational press. The cotton industry of England, we are sometimes told, for instance, is rapidly being lost to Japan. England has 59,000,000 spindles and Japan 3,690,000 ; on the face of it, Japan could make little show with such a burden of work as the transference of any considerable proportion of our spinning would mean. But when we consider the *kind* of spinning, the absurdity of such scares becomes greater ; for Japan's mule spindles number only 48,000 against our 40,000,000.

Although not so markedly foolish, rumours of inroads by other countries on our cotton industry are generally

based on very unstable foundations. If we take the case of our greatest cotton rival—the United States—we find that with 36,000,000 spindles she has to supply,



A RING FRAME.

as a first duty, the needs of a population two and a half times the size of ours, and that population much greater users of cotton materials than we. Our home trade consumes, roughly, one fifth of the cotton goods produced

here, which means that only 12,000,000 of our spindles are required for home consumption. On the same reckoning, America's home needs will consume the product of about 30,000,000 spindles, leaving very few for the production of export goods. That this calculation is not far from the truth is shown by the fact that the United States has been able for a long time to export only about 5 per cent. of her cotton goods.

It is, indeed, curious testimony to the wonderful stability of the English cotton industry and to its importance to the world (it is, too, an illustration of the folly of scares), that since the war it has filled a greater place than ever in supplying other countries. That does not mean that its exports have been greater in weight than before the war, but that its proportion to the world's total of cotton goods production has been a bigger one. When uninitiated people were talking, late in 1919, and early in 1920, of our cotton industry having inroads made upon it by America and Japan, the former country was actually buying more cotton goods from us than ever before, and the latter country was prohibiting the export of yarns of Japanese manufacture and suspending the duty on imported yarns! During the first five months of 1920, the United States bought from us 56,990,000 *square* yards of cotton piece goods. In 1919, during the same months, they purchased 8,225,000 *linear* yards.

It is difficult to compare the figures because of the alteration in official returns, square yards and not linear yards being now given ; but it is obvious how phenomenal the increase was. It has, however, to be recognised that 1919 was not a normal year, and that our exports to the United States and elsewhere were small because we could not meet the demand. The year 1913 is a better comparison, and in the same period of that year

the export from the United Kingdom to the United States of cotton piece goods was 17,836,000 linear yards. The amazing increase that has taken place is not accidental. What it shows is that the English cotton industry, with its enormous capacity for output, its collateral resources in the way of textile machinery works, and its faithful and skilled operatives, was ready very early in the era of peace to resume its full service to the world, and that it was in a position easily to outstrip competing nations whose machinery had been just as free from war damage.

Nor is the condition of superiority which Britain enjoys likely to be a temporary thing. All the general factors of the world situation may be said to be in her favour. Extensions and new constructions, which are among the biggest factors of the future, are more readily and more cheaply obtainable here than elsewhere. In America, Japan, and on the Continent, from one and a half times to double our expenditure will have to be incurred in putting up new mills. The fact that the textile machinists are so largely British firms, and that the cotton industry of the rest of the world has to look to us for so great a proportion of its machinery, must have a very important influence in maintaining the superiority of British equipment. Notwithstanding her efforts, with British help, to increase her textile machinery, America has not been able to get anywhere near us, and since the war the difficulty in her path has grown larger, seeing that a ring mill could not be erected there, in 1920, under 60 dollars a spindle, equivalent on the rate of exchange then ruling to about £15, or double the cost in this country at that time. In Japan at the same period, the outlook was equally unpromising. "The shortage of machinery was accentuated by the numerous flotations of textile

companies during 1919," says a report on Japan issued by our Department of Overseas Trade, in August, 1920, "and it is difficult to see how many of these concerns can commence operations at present. The position has resulted in considerable interest being shown in the local manufacture of spinning and weaving machinery. Although manufacturing costs of such machinery will be high, there is a vast amount of money at the disposal of the industry, and it is of vital necessity for the manufacturers to obtain machinery for their urgent needs." A survey of the cotton spinning and manufacturing countries of Europe shows their outlook to be much less favourable than that of the United States and Japan. And hence we may draw the conclusion that England, as a cotton manufacturing country, has a better prospect than any of her competitors. The fact that she is a specialist in fine spinning immensely strengthens her position, since it is precisely here that her lead over all rivals is most pronounced and most difficult to reduce.

If we go back to ask how the cotton industry of this country came to hold the favourable position it now enjoys, we find a whole series of questions rising up and seeking answer. Why, for instance, is the manufacture of cotton found at its highest perfection and in its most extensive phase in Lancashire, since all the raw material is grown thousands of miles away? Why has India, which before the Christian era was manufacturing by hand cotton materials of the fineness and finish of silk, now turned in the age of machinery to making coarse goods? Why has the growing of cotton almost disappeared from Europe? Once considerable crops were raised near Rome. Again, Spain was at one time an important cotton country, with Barcelona to the whole industry of that day in as central a position as

Manchester to-day? Why was the centre of gravity altered? It would require a whole history to trace the course of these changes and merely to recount the steps by which they have come about would not necessarily reveal their underlying reason. But we may here hazard a guess at the causes which have raised Lancashire to her unique and proud position. First, of course, she was among civilised nations very early in the field after the age of machinery had begun. She was, moreover, blessed with an energetic population, eager to explore new avenues of activity. For coal, water, and every other requisite of the industry she was favourably circumstanced. Inventions were worked out by her sons and developed by her great industrialists; and in all cases she got the first benefit of them. Finally, her operatives, not less skilful than hardy, showed a wonderful genius for the industry, and to-day there seems to be among them something very like inherited adaptation to this particular work.

A very remarkable period in Lancashire's cotton spinning industry, calling for special mention, was the decade before the war. In that particular ten years Lancashire had a fit of what at the time was thought by many to be sheer mill-building madness. One fifth of her spindles were built during that space.

It was as if unconscious prophecy had been at work. During the time these spindles were being erected there were forebodings of over-building, of a boom which could only end in a slump, of investments which would come toppling to waste through a surfeit of machinery. It cannot be questioned that, judged by all ordinary criteria, the people who saw these visions of a black future were on logical ground; there was far greater reason for what they, looking only at known facts, foresaw than for any calculations of a more hopeful

character. Lancashire, however, like the author of the celebrated book *Ben Hur*, builded better than she knew. One of the best known university vice-chancellors of this country once ventured the remarkable theory that the war was a coming event which had cast its shadows before it in some remarkable manifestations in art. Futurist and cubist art, he averred, in its revolt from normal canons, in its absorption in violent expression, in its love for motion and for the dynamic interpretation of static things, was due to the anticipations in the sensitive artist soul of the period of violence towards which the world was unconsciously heading. It sounds fantastic, and it would sound far more so if one tried to apply the theory as explaining why hard-headed, unemotional and insensitive Lancashire business men enlarged their industrial capacity by 12,000,000 spindles just at the happy time when such an accession to their productive means was going to be most valuable to the nation. Here we will not theorise, content to draw attention to the extraordinary good fortune that this expansion did occur, and leaving it to the reader to allocate it to happy chance if he likes. Suffice it that in the war these same new spindles were tremendously vital; that since they have served the world's clothing needs; and that to-day Lancashire has reason to be happy that the pre-war building boom survived the gloomy criticism which attempted to arrest it.

CHAPTER II

COTTON SPINNING AFTER THE WAR

No accurate record had been prepared up to two years after the war, of the loss and damage during the five years of hostilities. Some years will require to elapse before thoroughly reliable statistics can be compiled. Some general facts of importance may, however, be stated. The redistribution brought about by the war gave France an advantage in numbers over Germany by about the same total as Germany's pre-war advantage over her. Four-fifths of the Austrian equipment of spindles went to the new state of Czecho-Slovakia, leaving Austria a relatively unimportant factor in the European cotton world.

As to Russia, no estimate of any reliable nature, or even remotely approaching it, could be formed of the cotton machinery kept working under the Bolshevist régime, or of the condition of the mass of the machinery in its mills. The most contradictory reports came through. From one cotton expert, who returned during the early months of 1920, after a great many years in control of mills in the Moscow district, it was learned that only 12 mills of a total of about 1,000,000 spindles out of Russia's full complement of nearly 9,000,000 spindles were then running at all, and in these 12 mills only at most one-half of the machinery was operative. Corroboratory news came from other sources showing that not more than 15 per cent. of her cotton spindles had been in commission during the period of Bolshevik rule. All the stationary plant must have depreciated heavily, and it was probable that scarcely any of it would be usable until it had passed through

the machinists' hands. Germany was reported to have at the end of the first half of the year 1920 as much as 60 per cent. of her cotton machinery idle. In connection with Germany's position, again, the acquisition of reliable data of post-war conditions is most difficult. In June, of 1920, our own Government issued a Report on Industrial and Commercial conditions in Germany at the close of the year 1919, but not a word about the position of Germany's cotton industry appeared in that report—an omission which it was not easy to understand. Stray gleanings from more or less reliable sources showed, however, that at the end of 1919, great efforts were made to get machinery which had been standing idle again at work, and a measure of success attended the efforts. The raw cotton needed for finer yarns was then very inadequate ; indeed, Germany had scarcely been able to buy this kind of raw material. One need not attempt to make this enquiry exhaustive, but the case of Holland should be mentioned. The Dutch people during the war showed considerable enterprise in managing their industries generally, not least of all their cotton industry. While, after the stoppage of imports, their general clothing industry was increased, they went into new branches of textile enterprise, starting the manufacture of sewing-cotton and lace-making. Their methods were thorough, manufacturers who desired it being given instruction in special classes at the technical schools. Spain Italy, Belgium, Holland, Portugal, Finland, of the cotton-spinning countries of Europe, were working nearly normal proportions of their machinery within two years after the war.

The case of Poland, before its war with Russia, was interesting. The industry there, centred at Lodz, had about 1,500,000 spindles and 40,000 looms. Poland

has a good record in cotton manufacture. In the days of the kingdom the hand-made fabrics, spun and woven in the homes of the peasants, were known all over Europe. When, about 100 years ago, the modern factory system began to oust the remnants of the manual industry, the Russian Government, following principles which, as Lord Bacon tells us, Henry VII and, as we know ourselves, Wilhelm II thought to be worthy of rulers, encouraged the industry in every possible way. It gave free land and forests where they would be of benefit, and offered wide privileges to Saxon and Belgian cotton and wool manufacturers who were prepared to settle in the Lodz district. Employers who accepted these benefits soon induced skilled operatives to follow, and the industry, by wise far-sighted organisation, was given a sound foundation. In this way Lodz grew to be an important cotton-spinning and manufacturing centre; and, like the rest of the industry under Russian rule, it was actually built up to its modern strength, not merely on Lancashire models, but by Lancashire brains and skill. The name the "Polish Manchester" meant more than a similarity in the main industry: it meant that Manchester had sent out some of its best technical equipment to build up possible competition by making Lodz an effective unit in the cotton world. After Poland regained her autonomy she showed a full appreciation of the value of the cotton industry. It is Poland's chief industry. Of the 400,000 workers in old Russian Poland, 150,000 are in textile employment, 70,000 in the cotton mills.

Of course, though it is important to Poland, the cotton machinery of that country is not of any great moment as a unit of the world industry. Before the war the money invested in the industry was about £20,000,000. In pre-war times the value of its production was

£24,000,000. The new Poland has a population of 32,000,000, so that, on a very small consumption per individual, the industry in that country will for some time to come be able only to supply a meagre proportion of the needs of its own population. What makes Poland's cotton industry worth special attention, however, is the new impetus it received when the country's autonomy was restored. The securing of its long-lost nationhood and the formation of the republic caused an enthusiasm and eagerness in every branch of national life, not least in the cotton industry. New combinations of capital were formed, much as great combines were organised in the English cotton industry, and the most ambitious schemes for development projected. These were disturbed by the Russo-Polish war.

Perhaps it would be quite safe to generalise the position in Continental Europe, up to the middle of 1920, in the statement that not more than 30 per cent. of the spindles were in full activity. But any inquiry into the question of how the world's cotton-spinning industry now stands is only partially settled when we arrive at that point. Nothing is more certain than that many years must pass before it will be on a normal basis. Reliable estimates place the wastage of spindles during the four and a half years at something near 20,000,000, and it must be remembered that in the time that has elapsed since the Armistice, it has not been possible to obtain renewals at anything like the pre-war rate. Then, before the war, there was an average increase of 4,000,000 spindles per year ; so that we may assume, making every sort of allowance, that the world in 1920, was at least 30,000,000, possibly 40,000,000, spindles behind what would have been the existing number had things moved along the course they were taking before

the war. As in some measure counterbalancing the reduction of spindles, either by absolute destruction or by wear rendering them inefficient for full production, there was the waste of life in battle, by which demands of 10,000,000 people were stopped—against which, in turn, must be put the normal increase in population characterising practically every European country.

Bearing all factors in mind, it would perhaps be safe to say that the world demands on cotton-spinning machinery are now almost equal to what they were before the war. How are cotton-spinning countries going to meet that demand? Throughout the cotton world a reduction of hours has been going on. America instituted a 48-hour working week before this country reduced her cotton mill working week from 55½ hours to the same number as America. In other cotton-spinning countries a like change has been, or is being made. Now, in this country the institution of a shorter working week, it is estimated, neutralises about 8,000,000 spindles in the matter of production. Taken over the whole area of the industry, it would deprive the world of the pre-war production of, say, 20,000,000 to 25,000,000 spindles. Obviously, if the world demand for cotton goods is to remain at anything like its pre-war total, the machinery question is going to be one of the most vital that the next ten years will have to face. The problem cannot be a passing one; for if you added to the destruction and wear and tear of the war the loss or spindleage due to the reduction of the working week, there is a formidable leeway to make up. And it can be said with confidence that the first two years succeeding the Armistice did very little in that direction. It is true that reports appeared about the additions the United States, Japan and India, made to their equipment. It may be doubted whether any of them are

accurate, and certainly no figures have yet been produced to show that the production of these countries has reflected the accession of strength. One must apply the touchstone of our own experience in Lancashire to these accounts. At the beginning of 1920, statistics were issued to show that since the Armistice there had been an increase of over 1,000,000 spindles in our cotton industry. A sifting of this statement conclusively showed that very large numbers of spindles which had been broken up because of their out-worn condition had not been credited to the loss side of the account, and in several cases firms which had renewed machinery were found to have been credited with quite excessive equipment. This is inevitable in dealing with such matters, and could only be avoided by the mill-owner himself preparing an accurate return of the machinery discarded and the new machinery substituted, a thing he is not very likely to do merely as a means of satisfying a craving for statistics.

We see, therefore, that the outlook in the autumn of 1920 for the cotton trade was one both of promise and difficulty. In view of the leeway to be made up in re-stocking the world with cotton goods, and in maintaining the supplies for current needs, it seemed that, given adequate supplies of raw material, there was a period of some years of prosperity for the industry. Much will depend in the future upon the textile machinists. In 1920 orders up to, it is stated, three years ahead lay in their hands. Consequently, our engineering industry has been benefited very greatly by the world's cotton needs. The textile machinists faced the situation with enterprise. Unfortunately, they were very much handicapped in the first two years of peace. The moulders' strike at the end of 1919 upset the engineering industry, and, according to the

chairman of our greatest textile machinery company, not only was felt during the eighteen weeks that it lasted, but in the next six months as well. Further, in this industry, too, a shorter working week has been instituted, together with longer summer holidays ; so that unless there is a great extension of the works engaged in the making of textile machinery, the great task before them would seem well nigh impossible.

CHAPTER III

COTTON SPINNING MILL FINANCE

SOMETHING must be said herein of cotton-mill finance in several aspects, because it is a subject on which outside Lancashire a great deal of misapprehension exists. Undoubtedly, this was one of the factors in the great " boom " in mill, mainly spinning mill, shares of 1919–20. People saw reports of enormous dividends ranging from 10 to a fabulous 800 per cent. (in one case only the latter enormous yield was chronicled) and, of course, uninitiated investors came to the conclusion that here at last was El Dorado. The " boom " was a very big thing. In a very short time some scores of mills went into new ownership, and then new capitalisation was on a scale which seemed to dwarf the pre-war rates. But what was the truth of the situation ? Sir Charles Macara did an enormous service both to the public at large and to the industry by making the whole position clear while the fever was at its height. He showed that a method of finance was in operation which was peculiar to this industry, under which the dividends represented an enormous return during prosperous times on shares, but a much more modest return on the whole of the capital employed in the businesses. This, of course, arose from the dual system of capital : that is, loan and share capital. The shares, as he pointed out, often were no more than one-eighth of the total capital, and in some cases were only one-eighth paid up. The rest was loan capital, held on a fixed rate of interest. This was always secured, both capital and interest. It was safe from the fluctuations of the profits. The shares took the profits in large measure when trade was

good, but had also all the risk. This, as Sir Charles pointed out, explained why the enormous dividends were declared ; they were dividends on one-eighth or less—sometimes a great deal less—of the whole of the capital employed. They were most emphatically not a reflex of the profits being made by the industry. Spread over the whole of the capital involved in running the industry, the proceeds from trading represented a much more moderate yield. On a certain company declaring a 100 per cent. dividend on shares, for instance, the actual dividend on the whole of the capital, had its system of finance been that of ordinary public companies, would have been about 9 per cent. With the increased capitalisation of mills, Sir Charles Macara dealt in a manner equally effective. And, indeed, this was a self-evident necessity. Old values were among the things to which the war put an end. The position in the spinning industry when war ceased was that if you wanted to build a new spinning mill you must needs pay about four times what such a project would have cost before the war—assuming you could get anyone to build a mill—for the textile machinists were so overwhelmed with orders, mainly connected with the renewal of machinery which had been perforce neglected during the war, that they were not in a position to accept orders. Quite obviously, here was a situation calling for new valuations. Not only had the plant undergone this stupendous increase of value, but everything involved in the production of cotton goods had passed through a similar change ; and hours of labour had been shortened by seven and a half per working week, this reacting on the machinery values in that it made the products of that machinery more precious. In these circumstances the old capitalisations were inadequate and, indeed, trifling. From the point

of view of insurance a new valuation of the properties became necessary, for had a concern suffered by fire the old policy would not have yielded more than a small portion of what a new construction would have cost. These, then, were the factors of the so-called "boom"; they were not very different from what operated in practically all other great industries; but the system of finance obtaining in this industry gave uninitiated people an impression that a new and very deep mine of profit had been discovered in the cotton world.

Even now the impression subsists in certain quarters, but it has been removed in others where, since the "boom," the fluctuations of profit in the cotton-spinning industry have brought a truer perspective. This industry, it cannot too strongly be pointed out, is one in which the profits of a single period prove nothing. Only by working them out over a period of years can one see what sort of an investment cotton spinning is, and when this method is followed it becomes clear that it yields only a moderate return on the capital employed.

A book on the industry of cotton spinning would be quite inadequate which did not deal with the implications of the great "boom." Before the war one of the striking things about this great industry was that it had been very little touched by the company-promoter, who is that and little or nothing more. The big financiers had kept off it: a striking proof of what has previously been said of its moderate profits. Companies had been floated—indeed, the limited liability company was born among Oldham spinning mills—but by men who were actually concerned in running the businesses and who had practical experience of its requirements and the requisite knowledge for conducting its operations.

As regards a great portion of the industry that is still the case. Yet the element of pure financial operation has come in with some strength during the post-war reconstruction, and it is a change which cannot fail to exert an influence on the future of the industry. There have been various estimates of what amount of capital has come under the control of groups of outside financiers ; it has been put at £40,000,000 and at £60,000,000, and at more. The proportion does not matter : what we are concerned to do is to point out a new element in an old industry and to ask what its results may be. So far they have not been apparent ; no remarkable changes have taken place. Times of stress have not yet been felt. When they come, the old Lancashire owner or director of cotton-spinning enterprise will use that weather wiseness which has taken him and his great vessel safely through many a storm and between many rocks in the past. It will be hard for " pure finance " to steer as well as he ; and, indeed, if " pure finance " attempts it it will fail ; but if aided by men who have already passed through the same troubled waters it will get through ; for the cotton ship has a way, like the knowing horse, of arriving safely at its ends even when the handling and the guidance are only partially competent.

It may be mentioned, though the figures are given only for what they are worth, that it has been estimated that the value of the world's cotton-spinning industry in 1920, apart from stocks or other products or raw materials, is something like £800,000,000 ; of which England's share is about £350,000,000.

In connection with purely financial movements in the industry, it is of interest to note an extension of trade union scope and activity. For some decades the trade union of the operative spinners have been in many

ways a better organised body than is to be found in any other industry. By its capital intelligence system, which employers have not been slow to pay tribute to, it has been able to keep a more or less accurate account of the conditions of trade, national and international, and has often shown something approaching genius in selecting the moment for aggressive action. Time was when the cotton operative would never have dreamed of encroaching upon the purely financial side of cotton spinning, nor would their incursion into that realm have been mildly tolerated by their employers. But in the post-war cotton boom to which we have referred they were early active. The executive of the operative spinners' amalgamation, moved by apprehensions of damage to interests they had in common with the public, consulted with other branches of labour engaged in spinning mills and found that they shared these apprehensions. They held joint meetings to discuss what effect the reflotations would have, and came to the conclusion that the result would be to occasion a much higher cost to the consumer of cotton goods than was justifiable, "and that the material effects upon the operatives' interests, owing to the claims for dividends on the huge capital increases, were likely to be of an adverse character. It certainly would have the effect of much larger profits being required to give a return on the inflation of capital, and proportionately reduce the prospects of those profits being available for increases of wages or betterment of conditions." These sentences are given from the operatives' report. Their importance is not here of special moment, nor is this the place to discuss them, except as they mark a very interesting aspect of cotton-spinning organisation. In practically every other great industry, financial movements of a similar character to those in the cotton trade took

place in the first twelve months after the war. In engineering in all its branches they were especially marked. Even in agriculture the sales of farming estates, which were so numerous that England was said to be changing hands, were in principle not very different from the changes that went on in the cotton world. But it was not found that any other class of operatives took a like step to that taken by those of the cotton-spinning industry. The significance of this fact is made even greater by what followed ; for, instead of curtly replying—as might have been done years ago—that the province of finance was theirs exclusively, the employers took pains through their federation to give a considered answer to the fears expressed by the operatives' leaders. The Federation of Master Cotton Spinners believed these fears to be unfounded, and expressed the view that the ultimate effect of the transactions might be to benefit operative as well as employer.

The incident has a very special value in showing how far the perfection of organisation, of which both operatives and employers boast, is tending in the direction of common interest in all the things that concern the industry. It is given here as perhaps the most striking instance of the extension of trade union operations. It is also equally remarkable as an illustration of ready acceptance of a capitalistic body of working-class incursion into a field not very long ago held to be a preserve of the owner. On one side, which is the only one which can be touched upon in an impartial survey, it augurs well for the industry since the action of both sides implies a joint recognition of the fact that no sphere of the industry can be said to be beyond their common interests. It argues a realisation of inter-dependence and solidarity ; from this to genuine

co-operation and co-partnership is only a step, though it may be one which cannot be taken for some time to come. Since this event the workers have gone much further, even asking the Government to appoint a Commission of Inquiry to consider the financing of the cotton industry and the profits made, and suggesting nationalisation. Academic enquiry by a Commission is not likely to produce any great reforms, but the readiness to listen to each other, shown in connection with the question of the "boom," should help to those ideal conditions to which the cotton-spinning industry as a whole aspires.

CHAPTER IV

COLLECTIVE BARGAINING

THE organisations, both of capital and labour, in the cotton industry are perhaps the most highly developed yet reached. A number of reasons have conduced to make perfection of organisation possible. One is undoubtedly the compactness of the industry. Where an industry is spread over a wide area, with large spaces where it is not to be found at all, it obviously adds to the difficulty of co-ordination, of rapid communication and of administration. What might be called the district psychology or district temperament also comes into play in national organisations uniting a body of men over widely separated parts of the country. For instance, there is in general a very marked difference in the temperament and point of view of North and South, and anyone who has undertaken any organising work in which it has been desirable to urge unity of aim all over the country, is sure to have met difficulties which arose from this cause. In the cotton industry, particularly the spinning section, the concentration of the main body of interested persons in a fairly restricted area, together with the fact that they have shared a common outlook, has facilitated a more advanced development of the media for expressing the demands of the two main interests, and hence employers' and employees' organisations have grown more quickly than in other industries. There are, however, many other causes, some of which lie in the history of the industry and some in its special circumstances. One fact that may be mentioned is that the readiness to enter upon collective bargaining, which revealed itself in the cotton

industry at a comparatively early stage, is probably very largely due to the closeness of contact of employer and workpeople, which was a marked feature of its early growth. The old employer often lived next door to his mill; he knew his "hands" by name; he was daily among them; in village communities he traded at the same shops and worshipped at the same church. In very many cases he was in his origin one of themselves who had got a "move up" by reason of energy and uncommon acuteness. All this tended to make him see the more readily the justice and the wisdom of entering upon understandings and agreements with the workpeople or their representatives. Another factor was the persistence in the cotton industry of individual ownership of large concerns long after the development in other realms of the limited liability companies.

Both on the employers' and employees' side the organisation follows the plan of efficient local branches, district associations, and central federations. There are actually two employers' federations in the cotton industry, both having their headquarters in Manchester —the Federation of Master Cotton Spinners' Associations, and the Cotton Spinners and Manufacturers' Association. Though some spindles are represented by the latter, they are relatively few; and in times of general crisis, or in matters affecting the whole industry, the two bodies act in unison, so that for practical purposes they are really, at such times, one. As far as the spinning side of the industry is concerned, the first-named organisation only need be considered. In it are represented 53,000,000 of the 59,000,000 of spindles in the country. The Cotton Spinners' and Manufacturers' Association mainly represents the weaving section of the trade. The Federation has had a

very remarkable career since it was formed in 1892, with a membership that represented 17,000,000 spindles, which was then only about two-fifths of the number of spindles in England. In its earlier stages, its usefulness was always curtailed by the number of employers who remained outside its influence, since in times of dispute or crisis unanimity on the employers' side was difficult to secure. While the Federation might determine on one course of action, powerful units beyond its control often, for reasons of their own, decided upon another, and the division of aim often led to compromises which the Federation itself would not have approved. But from the very first it became clear that the Federation had a niche to fill, that its value to the industry would increase with increasing membership, and very soon after its formation a period of growth began which has continued to the present day.

On the workers' side, the Amalgamated Association of Operative Cotton Spinners and Twiners is the great central body. Its headquarters are also in Manchester. The total membership at the end of 1919 was 25,309, this amalgamation covering, of course, only a tithe of the workers who are engaged in spinning mills, the others being organised in other unions such as the Cardroom Amalgamation, etc. The Spinners' Amalgamation, most powerful of cotton trade unions, by reason of the high degree of skill of its members and their central importance to the industry as a whole, has carried trade unionism organisation to a very high degree of development. Its Executive Committee is almost ideally representative, whilst its quarterly delegate meetings fully express the opinion of operatives throughout the whole area. Any one of the Amalgamation's recent annual reports shows how much beyond the old type of such organisations it has advanced.

These reports are, in fact, educational documents. They keep the workers in touch with the many ramifications of their industry in a very competent fashion. They tell of pure trade union work done by the Amalgamation and in the "provinces" into which the spinning industry is divided; give the finances of the provinces and the Amalgamation as a whole; memberships, meeting places, and so forth; but they go beyond such routine. In the secretary's reports, both annual and quarterly, is to be found, as a rule, an admirably balanced review of matters of general interest to the industry, and of the steps that have been taken by one side or the other in cases where conflict of opinion or interest has arisen. Consequently, the reports keep main issues before the members as a whole, and those in areas unaffected by purely local disputes are kept informed of the points in dispute, the negotiations, and the results. Much information is given, too, upon matters which at one time would have been regarded as outside the province of trade unionism. The annual reports, for instance, contain a table giving for every month of the past year the prices of cotton and yarn, with average margins between the cost of the raw material and the price of the manufactured yarn. Of course, only the staple lines could be so dealt with, but this is done creditably and the employee gets from them a fairly correct view of the conditions of trading that have existed in the past twelve months. Another series of tables gives a complete statement of the export of cotton goods and yarns. These have a distinct educational merit, showing not only the extent and value of the trade done with foreign countries, but giving the particular destination of the goods, together with the quantities delivered to each country. The figures are given both in yardage and poundage, and

for the two preceding years to the one under review, so that comparisons may be made and progress or retrogression noted. Such information comes well from anywhere, since it opens the eyes of the worker to the importance and scope of his industry ; but it comes with especial value from his trade union.

Every now and then these great organisations come into conflict, and it is a struggle of giants which results. But there are generally very few outward signs as far as the negotiators themselves are concerned of the large nature of the forces engaged. Indeed, the joint conferences which take place between the executives of each side are ideally unemotional. A cold, precise statement of the claims of each side, the good-natured play of give and take, genuine attempts to see the full force of each other's contentions, are the striking feature of these conferences ; and if a rupture becomes inevitable and the mills have to be stopped till the issue is settled, the declaration of war is in most cases made without heat or excitement. So much it is necessary to say in justice to an industry which is so often trumpeted by the Press to be involved in labour disputes. The crises are often enough in existence, but the negotiations to avoid them and the temper in which they are met are in the main all that could be desired. The very constitution and practice of the two organisations ensure that disputes which reach to the point of joint conference must be on matters of great moment. For before they get to that stage, every local expedient must have been tried to obtain a satisfactory settlement. Many serious questions as to conditions of working or as to what is known as "bad spinning"—that is, where operatives feel that they have good grounds for complaint as to the material given them to work upon—are settled by local negotiation combined with appeal

to the central organisations. On the other hand, general wage demands are always matter for treatment between the central bodies, since the whole membership of both is affected by them. The reactions of the employers' and the operatives' federations upon each other are constantly leading to good results. Indeed, no joint conference of moment takes place without beneficial effects which show themselves, not only in the stiffening up of loose stays in the organisations, but in the increase of "sweet reasonableness" among the men controlling them. These reactions have had much to do with the later growth of central cotton industry organisation in efficiency and completeness. Another thing which has always been valuable in these organisations, has been the realisation that their concern is industrial and not political. Even in days when the intermixture of political and industrial affairs became general, the employers and the trade unions of the cotton industry remained convinced that the machines they had created for protecting their interests must be kept free from political bias. During the past twenty years there have been only two occasions where any political tendencies have been revealed. One was during the Free Trade controversy in 1903, when a number of people did show the party politics spirit. But the employers' leader at that time was a man who has never been seen on a political platform—Sir Charles W. Macara, Bart., then Mr. Macara—whose brilliant campaign, based only on economic arguments, is remembered still as having effaced the purely political aspect of the issue of those days. The other occasion was when, just after the war, advanced young Labour men among the operatives began to press the theory of direct action. Here, again, the authority of the leaders has been thrown into the scale against political tendencies ; and in the report

of the Council of the Operative Spinners' Amalgamation for the half-year ending 31st July, 1920, is the categorical statement : " Your executive have always on principle voted against the adoption of direct action on political issues." This independence of view, ability to steer clear of cross currents, and determination to keep strictly to industrial lines, are nowhere so strong as in the spinning section of the cotton industry, and they constituted a very valuable steadying factor in the period of unrest which followed the Great War. In passing it should, however, be mentioned that the cotton operatives' organisations as a whole in the second half of 1920 have begun to consider seriously a scheme which will make the United Textile Factory Workers' Association—which amalgamates the whole of the trade unions in the industry into one rather loosely-strung body—a semi-political organisation. The attitude of the operative spinners' leaders on this matter has been thoroughly democratic, for, while concealing their own views, they have strongly represented that such a change can only take place with the sanction and support of the members of the separate associations.

The fact that the Master Cotton Spinners' Federation and the Operative Spinners' Amalgamation have separate interests to maintain, even to the point, sometimes, of conflict, increases the significance of the unity of aim they show in endeavouring to promote the interests of the industry as a whole, and gives greater significance to the movements in which they have shared and the agreements they have reached. It is not too much to say that industry as a whole is indebted very largely to them for the lead they have given. At present, in some Government Departments and in a number of industries, the sliding scale principle for adjusting wages to the cost of living is in use upon a

plan which has much in common with that hammered out in cotton spinning twelve years ago, known as the Scheme for the Regulation of Wages. Though it has been little used in cotton circles latterly, it still may be called into effect when occasion arises. Sir Charles Macara, who was mainly responsible for originating it, proposed early in the war that the scheme should be applied to all industries, foreseeing that a period of unsettlement of the cost of living and of labour would come in the train of war. It was not applied in general, and there is good reason for the view that the failure to adopt some such course let the country into many strikes and disputes ; for in the Employment Exchanges and elsewhere it has been made evident that these automatic adjustments work well in conditions such as obtained towards the end of the war and have ruled since. Where they are strained and may break down is when the cost of living descends, involving reductions of wages. The chief value of the original Scheme for the Regulation of Wages was that it avoided the pit-falls of basing wages on outside conditions, and made the earnings of the spinning industry itself the basis of calculation for wages purposes. The standard lists in use in the industry are another example of fruitful joint work between the two sides : these remedied many inequalities which operated to the disadvantage of the generous employer, while they gave the operatives an agreed wage which could not be varied by any act of the employer.

There have been very notable joint arrangements as to working, which have carried the industry over times of great crisis. Invariably, something of permanent value has remained after the crisis has passed. During the first three years of the war there was no control of the cotton industry, save what was involved

in the closing for a short time in the early stages of hostilities of the Liverpool Cotton Exchange. No great loss was suffered by lack of control, even though the industry was very largely a war industry, but on one occasion there seemed every prospect of serious trouble, a dispute of the Cardroom workers being " proclaimed " under the Munitions Act, in June, 1916. The last seventeen months of the struggle saw the industry under the Cotton Control Board. The Government supervision of the industry through this Board was on good lines : the Board of sixteen members consisting of seven representatives of the employers and merchants, seven of the trade unions, and two of the Board of Trade. How the Cotton Control Board carried out its work is pretty well known. The point it is of interest to stress here is that employers' and workers' representatives worked together on it with harmony and a single aim, and were able to inaugurate movements which may yet bear good fruit in industrial organisation. Lord Askwith's scheme that unemployment in an industry should be a charge upon the industry, advocated since the war, was here actually in operation ; for when it became necessary to restrict the number of spindles running on other work than Government contracts and special classes of work, the spinners who were allowed to run above the restricted number of spindles were levied, and the proceeds of the levy were used for the payment, through their trade unions, of unemployment benefit to the operatives who were thrown out of work—or " played off "—by the enforced stoppage of machines.

The very notion of organising by agreement a reduced output, which was the central principle of control of the industry, was itself not new to cotton spinning, though perhaps other industries had no great experience

of it. It had been applied years earlier, employers and employees acting in concert, to meet a desperate situation in the trade. The shortage of the raw material in 1904, gave a great opportunity to gamblers on the American Exchanges and one remembers the meteoric career of Sully, the speculator, at this period. The spinners and their employees then hit upon organised short time, which, of course, had the same effect in regard to output as reducing the number of spindles, and by cutting down the hours worked in the mills from 55½ to 40 they defeated the gamblers and tided the industry over a very dangerous period. Here, again, unemployment loss was avoided, the workers being all on reduced earnings but still kept at work. Both these principles of organising reduced output and preventing unemployment, or at any rate spreading unemployment loss over the whole field, have taken hold on the imagination of the leaders of the industry as the best means of meeting such crises as come upon it from outside. Moreover, the success of plans made by both sides in joint harness, has had a psychological effect not to be lightly valued. For now, if drastic action is necessary to meet a shortage of raw material or a slump in trade, it is acknowledged that the workers should be conferred with and their consent won, rather than that the action should be, as of old, in the decision purely of the employers. There are still many employers in other industries to whom such a consideration might appear quixotic : it was, when first shown, an anticipation of the new partnership of employer and worker in industry, and to-day it is still a little ahead of general practice.

The most important product of joint action, however, was the agreement which in 1893 brought a twenty weeks' strike to an end. The Brooklands Agreement,

often spoken of as a wonderful piece of industrial statesmanship, did a good deal more than end a disastrous stoppage. It, in fact, introduced the principle of joint government of the industry along the lines which the period of Cotton Control found so beneficial. It has been described as " the first and greatest and, indeed, the model of all treaties between capital and labour."

A writer who went through the whole of the difficult period of the framing of the agreement, gave in the *Cotton Factory Times*, in May, 1920, a sketch of the negotiations. " In the arranging of the joint conference of all the parties concerned," he says, " great secrecy was maintained. Those summoned were not to know fully where they were bound. The operatives' delegates, who were first of all summoned to their headquarters at Blossom Street, Manchester, resented being treated as though they were children, and some threatened to decline to go by train unless they were told of their destination. So stubborn were they that one official, to ease matters, promised to inform them when they had got into the train, and he had to carry out his promise." An illuminating light on the tense feeling of the hour is thrown by that passage. The place of meeting, so studiously kept secret, was, of course, the Brooklands Hotel, Brooklands—hence the name of the agreement—a suburb on the Cheshire side of Manchester. The same writer shows vividly how determined was the effort which resulted in peace and the great agreement. " Seldom was a conference held under such unpropitious circumstances. But the men concerned set out resolutely to hammer out the points, assisted by solicitors. Men threatened to break away, so difficult seemed the task. They wanted to go to their homes. Their colleagues button-holed them and persuaded them to stick it, to continue the struggle

to find a basis of settlement. Hours passed by and it was well on in the morning when the tension was relieved." This all-night sitting ended in the settlement which ruled the cotton industry for over twenty years. It took about fourteen hours to frame the agreement, but it was the best-spent time capital and labour have yet known. Even to-day, though the Agreement was abrogated several years ago, its spirit remains alive in the industry, as we have shown, and beneficial hints have been gathered from it and used in other industries. We need not deal in detail with the clauses of the Agreement ; the letter is now dead. But it may be said that its confession by both sides that disputes were futile, its recognition of the rights of employees to a say in regard to their conditions of work, its provisions for preventing the re-opening of old disputes, and its system of " courts of appeal," as they have been called, to which disputed matters could be referred were all based upon really statesmanlike ideas. The best tribute to its completeness and soundness was that it achieved its end, making the cotton industry for twenty years not as formerly the cockpit of strife, but a harmonious and prosperous organism, only twice in that period thrown out of joint and then by disputes which were due to feelings which no agreement could assuage.

Both employers and operatives in the cotton industry have their international organisations. The International Federation of Master Cotton Spinners' and Manufacturers' Associations is probably one of the most powerful industrial organisations in the world. On the resumption of its sittings after the war, at Zurich, in June, 1920, its founder and first president, Sir Charles W. Macara, Bart., issued a review article on " Internationalism in Industry," which was circulated

widely in Europe and America. In it he showed that the International Federation before the war had carried out work of enormous importance in developing the cotton crop of India, improving that of America, and in seeking a unity of aim in making the whole industry of the world efficient and sound. The record of work done by the International Cotton Federation, as shown in that article by its founder, is remarkable ; and Sir Charles points to much more important results in the future in the following passage : " The International Cotton Federation has made it clear that men of different nations will readily work together for the common good. . . . All that is necessary to make an effective League of Nations is to foster in the world of diplomacy and policy the spirit which has animated this great organisation. I do not say that is an easy thing to accomplish, but I do say that it is not impossible."

CHAPTER V

THE RAW COTTON POSITION

THE world's supply of the raw material is a subject of immense anxiety. Roughly speaking, the average annual yield of cotton in all parts of the world is 25,000,000 bales, of which several million bales can be ruled out as unfit for Lancashire's purposes. America is the main source of supply with an annual average of 13,500,000 bales of 500 lbs. each. The Lancashire spinning industry is always faced with the immense problem of an adequate supply of the raw material, and hence, any work dealing with that industry would be incomplete if it did not deal with this problem in some way. The English cotton industry imports all its raw material and exports about three-fourths of its products. One part of its raw material problem lies in the hands of people outside the Empire—the Americans. Can America be looked to for helping the cotton industry of Lancashire, or of Europe generally, to a solution ? Two facts seem to indicate that she cannot. One is the increasing consumption of her own machinery. To point this out is not meant to give strength to the rumours so frequently raised, one knows not from what motives, that American competition in manufactured cotton goods is likely to make very serious inroads on Lancashire trade. That fallacy has been dealt with elsewhere in this book. There is very little danger that America will challenge British supremacy on the world's markets. She has a population of about 110,000,000, generally speaking, a population which is a larger consumer of cotton goods in proportion than ours ; her spindleage is not much more than half that of Great Britain. Before the war she was able to

export only 5 per cent. of her cotton manufactures, and with an increasing population and the high price of textile machinery and the difficulty of getting additional equipment, one may say the probabilities are that she will diminish as a competitive factor rather than increase. The increase in the consumption of the raw material of which we speak, therefore, does not imply a development of her export trade in cotton goods, but one necessary to meet her home needs and maintain her proportion of exports. The second reason, a highly important one, for assuming that the United States will not be able to help the rest of the world materially in a solution of the raw cotton supply, is the fact that her crop is near its limit, unless conditions alter. It is doubtful whether the decrease of acreage under cotton which occurred during the war can be more than compensated for in the next ten years. After the war it became evident that expansion is not a simple thing, despite the endeavours in new fields in Arizona and California. The labour difficulty is a factor which makes for limitation. This applies especially to picking. The American picking season lasts only for 90 to 100 days. The average day's work of a man or woman picker is about 33 lbs. of lint cotton. To pick a crop of 14,000,000 bales therefore requires 2,100,000 workers. That excessive amount of labour is difficult to get, and the war did not in any way tend to ease the difficulty. Cotton plantation workers went into various industries of the South and North, and the life in more populous places and the higher wages kept many there. A bigger crop in America will involve an addition on large lines to the depleted picking strength, and there is good reason for believing that this will not easily be possible to obtain. A mechanical cotton picker would be a godsend to the planter. America, with her great genius

for invention, has struggled with this problem in the past, but so far without the happy result desired. Mechanism for the purpose has been devised, but it has been invariably discovered that the product of the fields suffered when it was used. So far invention has proved sterile in regard to a satisfactory solution of this problem. For instance, there was ten years ago a great flourish of trumpets about a very ingenious cotton picker. In tests near Wallas, Texas, under every-day conditions, we were told, a machine picked 153 lbs. of seed cotton in exactly 20 minutes. The speed was an acre per hour, and from 93 to 98 per cent. of the open cotton was gathered. Moreover, comparison with hand-picked cotton, in the eyes of the judges of the test, showed that the machine-picked cotton was in the better condition: no dirt, no leaf, or at any rate, a minimum of the latter, and each seed was separate and loose, thus permitting the gin to clear the fibre from the seed more thoroughly. Now this machine was held forth as the fulfilment of the dream of a century, the perfect mechanical cotton picker, its advent presaging economic and social revolution in the South. A million dollars and 25 years' work had been expended on perfecting it. One good mechanic and a boy could operate it. Yet to-day nothing much is heard of this cotton picker, and America is asking yet when will the perfect mechanism arrive. So we see that viewed from the angle of America's own increasing consumption and from the difficulties which stand in the way of expansion of her cotton crop, it would be foolish to expect from her harvests any greater help than that she now gives to the rest of the world in the matter of raw material. Wiser would it be to anticipate a reduction, and to make arrangements to meet the deficiency.

How valuable a perfect cotton picker would be can only be realised by seeing in their full nakedness the difficulties of labour in the South. Harvesting of the crop should be done quickly, of course. Where all the cotton in an area is ready for picking at one time, the effect of a great storm might be to destroy a third of the crop, while the rest would be reduced in value. It is at such times that the labour difficulty assumes its keenest edge. Planters, eager to harvest, begin to outbid each other for workers, wages rise apace, and the scarcity becomes more and more acute. All this is lost sight of in manufacturing centres, where the bale of cotton is regarded as the starting point. But this shortage of pickers, together with the proportionate decline of the Southern population in relation to the United States generally, is of great concern to European cotton concerns, and to Lancashire especially, as the greatest consuming centre. It points the need of intense effort to meet the raw material situation and to put the future of the industry into a secure position.

What are the remedies for the possible shortage of the raw material? They are numerous: put in order of importance, the principal ones might be said to be (1) Cultivation within the British Empire. (2) Better handling of the American cotton crop. (3) Establishment of a reserve of cotton. It would be outside our purpose here to deal exhaustively with these alternatives; but no book on the cotton-spinning industry could maintain the pretence of being practical if they were not alluded to. The first, so it would appear, is the surest hope for meeting the situation. If one speaks only of British Empire cotton-growing, it is not to imply that the work of other European cotton-using nations, in attempting to cultivate the plant more profitably in their colonial territories, is neglected or

negligible. On the contrary, these efforts are of the utmost importance ; but their scale is dwarfed by the immensely greater schemes within our empire, as their spinning and manufacturing interests are dwarfed by those of this country. Even during the war progress was made in cotton cultivation in the French colonies, and the efforts now being made by the Association Cottonière Coloniale, and private business initiative should do much to help France's cotton industry. In 1918, the latest year for which figures were available at the time of writing, the production of cotton in French colonies amounted to 6,340 bales, representing at prices then current a value of 30,000,000 francs. To our vaster needs, such a number of bales may look insignificant, but to France they have a very high value ; and the whole industry in that country is growing more and more interested in cotton-growing projects within their colonies, as is shown by the readiness French spinners showed after the war to agree to levy themselves one franc per bale of imported cotton in support of colonial cotton cultivation. Similarly, Belgium is devoting the greatest attention to cotton-growing in the Belgian Congo. The Belgian Government's Congo scheme embraces the cultivation of cotton and rice, two indigenous crops, which can be cultivated on the same ground. The whole of the work is being carried out with the greatest thoroughness under the supervision of an American expert, Mr. Fisher. There are experimental farms, with gins and presses, and an extensive propaganda has been carried on among the natives to win their co-operation in cultivating the plant. Many of them have been won over ; in fact, their joy at large earnings for the very little work necessary, has made them enthusiastic. Most careful experiments with 30 varieties of seed, American, Peruvian and Egyptian,

have resulted in the selection of suitable sorts for the Congo conditions. The Belgian consumption of cotton is 250,000 bales a year, and with the energetic measures the Government are taking for cotton cultivation, she sees a time in front of her when she may have a very profitable harvest in the Congo. The case of Spain is especially interesting. It has an ancient honour in the cotton industry. Within the country itself there is much land suitable for growing the plant. According to one authority, this land amounts to more than 2,500,000 acres. Much of this is not yet irrigated nor can it be for some years, owing to the enormous cost. Consequently, the main effort of the cotton-growing experts is directed to the possibilities of the dry lands.

Cotton-growing within the British Empire received a strong urge forward during the war. The great upheaval brought the problem into prominence, and gave the rulers of the country the chance of seeing the subject in the same light as people engaged in the industry. Up to the war, the movement for British cotton-growing was not generally understood. It is certain that a great many people misunderstood its motives. They thought the matter one of purely Lancashire concern, and looked upon any appeal for support as an attempt to get undue help for a powerful industry which should be able to carry its own burdens. Lack of general interest in the public, inertia in the Government, were encountered when any special plan for encouraging cotton-growing in the Empire was brought forward. Financial support was not the prime need ; for Lancashire has never shown any hesitation to put its hand into its pocket for necessary works. The prime need was to get Governments and the general public to realise that the subject of securing an adequate supply of the raw material for our greatest export industry was of

first-rate importance : of national not of local concern. Now, the war did in a measure effect this as far as the more intelligent students of economic affairs were concerned. Cotton rose to a new importance in the public mind. It was an indispensable ingredient of high explosives ; it was needed in ever greater measure for aeroplane cloths ; it clothed ourselves and our army ; its export during the war was the principal buttress of our diminished export trade. Though, in a measure, these aspects of the industry were accidental, their great importance in a crisis of national life did what no amount of propaganda in peace time could have done ; and the result of the focusing of national attention on the industry in this way was a greater appreciation of its value to the national life. The outside man got, as it were, an inside view. He saw the immense consequence of a proper supply of the raw material. Reflected in Parliament, this increased interest meant Government help in cotton-growing schemes, and so, after much valiant work from within the industry itself, the appointment of the Empire Cotton-Growing Committee was brought about.

The post-war danger that one observes in statements concerning British cotton growing experiments is, perhaps, too much optimism. There is an incurable tendency in the human temperament to regard things decided upon but not accomplished as being, in effect, practically in being. Illusions of this sort are observable in much that is written as to the cotton India, Egypt, and Mesopotamia are capable of yielding ; for often the very glowing picture is painted in a way that suggests that the harvest is already there ; whereas, and this every man definitely associated with the cotton growing movement knows, the true picture would show only a small area giving its fruits and the rest as a

very, very long row to hoe. It has taken America 140 years to arrive at an average crop of 13,500,000 bales. The British Empire crop will require to exceed that crop : for, as we have shown, the United States may be at their limit of production and very far from their limit of consumption. The 8,000,000 bales the United States now sell annually to the world, mostly to Britain, will in all probability be a dimishing quantity. World population is growing, consumption of cotton goods is increasing, and so the production of the raw material over the whole world will need to be larger ; and hence there is little doubt the demands upon the British Empire fields will ultimately be greater than on the American.

In these circumstances, the cotton-spinning industry looks with great interest upon the increased efforts for cultivating cotton in the Empire. In several fields where work is projected, years must elapse before any progress can be made. Mesopotamia, for instance, early in 1921, was not in a state of peace. The Sudan scheme was only at its beginnings, however golden the promise, and in the rest of British Africa good results had been gained, and if transport can be made available on a large scale, progress should be rapid. What Egypt has done is known. The developments there have the happiest augury. Then we come to India. Here the crop of 4,500,000 bales of 400 lbs. each, would seem, on bare figures, to be a greater factor than in reality it is. Whilst the bulk is great, the quality renders the Indian crop a much less helpful factor in the actual event. This, however, should not deter us from recognising the magnificent work that has been done by and in India, nor from recognising the conditions making for success it possesses. Transport, labour, climate are there ; and these are the three great

desiderata that lie at the foundation of success. The efforts which have been concentrated on the improvement of the staple have shown promising results, and, although great difficulties exist, which will render the improvement of the crop a very gradual process, yet India may at some not very far distant date be able to solve a good portion of the raw material difficulty.

The better handling of the American crop is one of the things to which we turn as a help in dealing with the scarity of raw cotton. A more obvious reform was never more consistently overlooked and neglected than this. Every international conference for over a dozen years has pointed to it, yet to-day there is almost as much need of agitation as ever. Trace the course of the cotton from the plant to its shipment from an American port and at every stage, except in the rare instances where new methods have of late years been installed, there will be found methods which result in waste. Mr. W. G. Turner, an American writer, in *A Story of Cotton,* a curious little book published in 1919, makes some strange revelations of the primitive methods of handling the crop. He enumerated the times when bales were cut open for samplings, and showed how each opening of the bale was accompanied by waste. Speaking of large planters who cultivate and handle all the cotton produced on their plantations, operate their own gins and, perhaps, gin cotton for others, he says : " They may sell their cotton to a buyer direct on their plantations, but always, of course, by sample. To produce this sample they must cut the bagging of the bale of cotton, unless a sample be drawn from the bale while ginning and baling. When the cotton is not sold at the point of origin, or even when it is sold locally to a country storekeeper, the local storekeeper usually re-sells, when he has accumulated a sufficient number of bales at the

local point from individuals or from his own plantation, to cotton buyers' representatives. The cotton buyer then usually cuts the bale again, and draws a sample of from six ounces to one pound, and ships this cotton to near-by concentrating points, to a warehouse, or compress for subsequent re-shipment abroad or to mills. . . . . It is again usually sampled by the representative of the buyer at the concentration point or by the compress owner on behalf of the buyer, and may also be inspected on the head and frequently at the sides with augers." All these samplings, the author contends, occasion waste amounting in a season to millions of dollars and necessitate the repacking of the bales. He thinks they could be rendered far less frequent and destructive, and yet all the conditions of just sales fulfilled ; and one does feel that it is a very primitive system which cannot make one thorough sampling do for the bale all along its course. Mr. Turner shows that other waste occurs. Dealing with the case of cotton sent for storage, he says that if the warehouse is not a modern one the bale may be rolled on the ground without cover and, if the weather is unfavourable, the bale is naturally damaged by this treatment. On the cotton markets there are further samples from bulk. All the samplings are accompanied by the scattering of loose cotton, i.e. the flakes pulled off the samples or from the bale itself when a presentable sample is being made. Although all loose cotton is collected, it is, of course, depreciated by having been thrown about ; and, inasmuch as the original owner of the bale often loses the value of this loose cotton, it has a tendency to affect his prices, if only to a very slight extent. But the real pity seems to be that good material should be turned to less good through what seem quite stupid methods. Besides this sort of damage and waste there

is that arising from the exposure of part of the surface of the bales owing to inadequate packing ; much of the covering used is low grade, a merely nominal covering ; and the wide mesh often used is itself a source of damage and waste. Mr. Turner says that those concerned in the handling of cotton have not given sufficient attention to the subject of damage by exposure and by wetting, the latter being the principal source of waste. He shows that an uncompressed bale of cotton of standard measurement leaves the gin with 2,016 sq. ins. of its entire surface of 10,692 sq. ins. uncovered : it being the custom to leave the two flat sides partially bare. Of the remaining 8,676 sq. ins., 58 per cent. or 5,032 sq. ins. are not covered owing to the wide mesh of the packing. " Approximately," he says, " every standard bale of uncompressed cotton of an average crop of 13,000,000 bales annually produced in America is placed upon the market with 66 per cent. of its surface uncovered and liable to a possibility and a probability of damage." Mr. Turner contends that " the producer, the ginner, the merchant, the warehouseman, the steamships, the consumer and the railroads should be compelled to shelter cotton and keep it dry from the time it is picked from the boll as seed cotton until it is finally consumed in the mill and that the millions on millions of dollars of waste at present obtaining, due to criminal neglect, should be forever stopped." Even if much of what he says is exaggeration there is a substantial case for a reconsideration of present methods ; and, indeed, many improvements are being instituted by the more progressive planters and ginners with beneficial results. The cotton saved would be of the greatest value as a factor in avoiding shortage of the raw material of the industry.

Fortunately, the raw material difficulty which is

ever and anon raising the spectres of idle machinery and wholesale unemployment is now receiving State attention. It is due to the energy of the leaders of the industry and the British Cotton-Growing Association that this recognition of the national importance of the subject has been brought about. The Empire Cotton-Growing Committee, in August of 1920, issued a draft of its scheme under the title "Future Organisation," a document which at once received the careful attention of experts in the industry. The scheme prepared was adapted to countries in which cotton cultivation has not as yet been largely developed but, as the Committee say, "Many features of the scheme will be of assistance to all the cotton-growing parts of the Empire. Though it is probable that some of the more highly organised of these, such as the Dominions, India and Egypt, will prefer to finance their own arrangements, in whole or part, the Committee will be glad to co-operate closely with such countries, and on their invitation to extend to them any portion of the proposed organisation which may prove acceptable." The work undertaken falls under four general heads—administration and research at the headquarters in London, research stations abroad, supplementary staffs overseas and pioneer work, education. It is estimated that an income of £200,000 per annum will be necessary, and proposed that the funds be provided jointly by the trade interests and the British Government. The staff will have a great deal of work to perform in the way of effecting liaison between Government Departments, local administrations and planters, between cotton-growers and other workers on cotton-growing, in such a way as to collect and spread all the latest information from and over the widest area. It will form and control an organisation for keeping in touch with local developments in all

countries in the Empire which actually grow cotton or are suitable for growing cotton, in the latter of which it will organise pioneer work. On the scientific side it will survey and record experimental work, disseminate its conclusions, collect full knowledge of characteristics of all the varieties of cotton, and foster research on practical methods. A commercial department of the central staff will undertake such tasks as valuing cottons and keeping in touch with markets. One of the best features in the Committee's scheme is the suggestion for the employment of selected men as travelling commissioners. They would, with the right equipment and the necessary enthusiasm, prove about the most sensitive antennae of the organisation ; for they would correct the tendency which always develops in large organisations for branches to carry on, quite efficiently, as separate unities. The Committee lays special stress on this proposal. "In the development of cotton cultivation," the report says, "reliance cannot be placed solely or even mainly on a central office in London. Any plans for supplementing the staffs of local agricultural departments and for useful expenditure to supplement their efforts must be first discussed with the local administrations and local agricultural departments to insure their co-operation and assistance. The various countries should also be visited periodically to promote the maintenance of a full understanding with local administrations. In cases in which exploratory work is organised directly by the Committee, or men happen to be employed abroad directly under the Committee, periodical inspection is necessary. The central offices thus need the services of travelling commissioners, free to tour, who should be able to spend sufficient time in the countries they visit to absorb local conditions. Four such men will suffice. At first

they will probably be mostly engaged in bringing back suggestions as to how local efforts can be supplemented, whether capital is required for cotton-growing in particular localities, and what further exploration is needed. Agricultural knowledge and administrative experience is desirable in these travelling commissioners."

At the time the report was issued the Committee's intentions as to research were not defined in detail, but it is clear that they give it an important place in their scheme. The intention is to proceed upon three lines. (1) The establishment of a special cotton research station or stations abroad. (2) Assisting in providing facilities for training men for the various agricultural services. (3) Assisting in selecting men for special work on cotton abroad. The research stations will conduct the higher research regarding the cotton plant, as distinct from investigations designed to promote the interests of particular areas. In their proposals for supplementing the staffs of agricultural departments overseas and pioneering, they grasp the fact that cotton requires a special attention, apart from the attention given by the agricultural departments to crops in general. So in regard to education they have modelled their proposals on the lines of the most progressive opinion in the industry. What does now seem necessary is energy in carrying out the large scheme unfolded in the Committee's report. The driving power will need to come from the industry itself, as is generally the case where the State undertakes work in behalf of an industry.

CHAPTER VI

EARLY SPINNING INVENTIONS

SPINNING has been defined as the art of twisting fibrous substances into a rounded yarn fitted for weaving, to which purpose it is necessary that uniform quantities of fibre should be drawn out in a continuous manner and that the material so drawn should be twisted so as to give it coherence and strain-resisting power. From what has been said elsewhere concerning the staples of varieties of cotton it will be seen that in an exceedingly rare case this art has combined fibres of not more than $2\frac{1}{8}$ inches long into a continuous thread of over 4,000 miles, having practically an equal strength over its whole length. Some writers have found great interest in speculations as to the discovery of spinning, and idyllic origins of the art have been imagined. A pretty conjecture is that of the writer who imagines a shepherd boy playing with fibres of wool while tending his flock, twisting them between his fingers, and so discovering that they could be lengthened into a thread, and carrying his discovery further by attaching his thread to a twig which he twists every now and then and uses for winding up the still longer thread that he obtains. Mythology makes spinning a gift of the gods. On these speculations it would be pleasant to dwell, but there is no data which would guide us to a knowledge of the exact circumstances under which hand-spinning first began. It seems pretty clear that all ancient civilisations practised the art. The linen robes of the ancient Egyptians not only imply knowledge of spinning and weaving, but also of a high degree of decorative finish in the fabrics. It would seem that they wore sometimes garments

MISS ALISON MACARA, GRAND-DAUGHTER OF SIR CHARLES MACARA, WEARING HAND-SPUN AND HAND-WOVEN FROCK.

(*See frontispiece*).

which were rounded off with counterparts of our rich laces. Homer mentions the weaving of garments and, indeed, Penelope's loom, with its constant activity, might almost be taken as a symbol of an industry which is ever in operation, though to greater effect than its prototype. The spinning of cotton fibres is only one branch of the wider art, and probably not its oldest branch. Its earliest examples, also, are hidden in the mists of antiquity. Centuries before the Christian era cotton was spun and woven in India into the very finest textures; the father of history, Herodotus, mentions them. India's hand-spinning, indeed, seems to have gone on through the ages with the same degree of perfection, anticipating the delicacy and finish that came to us only when the spinning mule had been brought into being. There are in existence in a Lancashire home to-day garments made from cotton spun and woven by hand in India ninety years ago, and expert opinion has pronounced the fabric as fine and soft as anything yet produced by our machinery. On the previous page will be seen a photograph of Miss Alison Macara, grand-daughter of Sir Charles Macara, Bart., wearing a frock which is a product of handwork from its initial to its final stage. The cotton was sown and picked by hand, spun and woven by hand nearly a century ago, and is yet of the greatest beauty and delicacy of texture. Among modern experts there are some who doubt India's capacity to produce raw cotton of the finer varieties, but there is ample and conclusive proof that she has done so in the past. Europe is supposed to have become acquainted with cotton goods when they were brought from India by Mahomet's followers. The spinning of cotton developed on the Continent very slowly. Spain grew and manufactured cotton in the tenth century, and Italy in the fourteenth. America

must have used cotton for making clothing for centuries, since it was used extensively among its inhabitants when Columbus reached its shores. Our own history in the matter of cotton spinning is not clear, but its introduction here must have been earlier than the date usually assigned. That date is generally placed in the sixteenth century, but probably it marks only the time when it became sufficiently important to be mentioned as a separate material. It is interesting that although America had a long start of us in knowledge of cotton and its uses, she lagged greatly behind us in developing its manufacture, a fact which cannot be said to be accounted for entirely by her earlier inferiority in population. With increased population and resources she has never been able to catch up ; and it is a paradox that although she has supplied us with the raw material of cotton spinning for practically the whole of the age of the cotton factory, she herself had no cotton-mill till the industry was well started in this country ; indeed, we have one or two cotton mill firms still in existence whose business dates to a period anterior to the first American cotton-mill.

Whatever the origin of spinning there can be no question that the spindle—which, as has been shown, may first have been a twig from a tree—has an industrial importance equalled probably by not more than two or three of the inventions of man. The earliest manufactured form of it that we know is that shown in the drawings of classical times—the spindle and whorl. The spindle was a tapering stick ten or twelve inches long, and having at the top a catch or slit to hold the thread firmly. It was rotated against the body, so giving the requisite twist. The whorl was a small wheel or weight of wood or metal into which the bottom end of the spindle was placed. It helped rotation and held the

spindle more steady. As each length of thread was spun it was wound on to the spindle, and, of course, when the weight of the thread on the spindle was sufficient, the use of the whorl became unnecessary. With this primitive spinning apparatus the spinster used also the distaff, which was a stick or staff on which was loosely bound the bundle of fibre which was to be spun. This was either held in the left hand, beneath the left arm, or stuck in the belt. It was in this way that all the earliest spinning was done. A Latin poet has described it perfectly for us in the words—

> The loaded distaff in the left hand placed
> With spongy cloths of snow white wool was graced ;
> From these the right hand lengthy fibres drew
> Which into thread 'neath nimble fingers grew ;
> At intervals a gentle touch was given
> By which the twirling whorl was onward driven ;
> Then when the sinking spindle reached the ground
> The recent thread around the spire was wound,
> Until the clasp within the nipping cleft
> Held fast the newly finished line of weft.

We shall see, in considering later devices, that in this primitive apparatus were the essentials of the most modern appliances ; the extensions made were matters of degree and of multiplication of the principles.

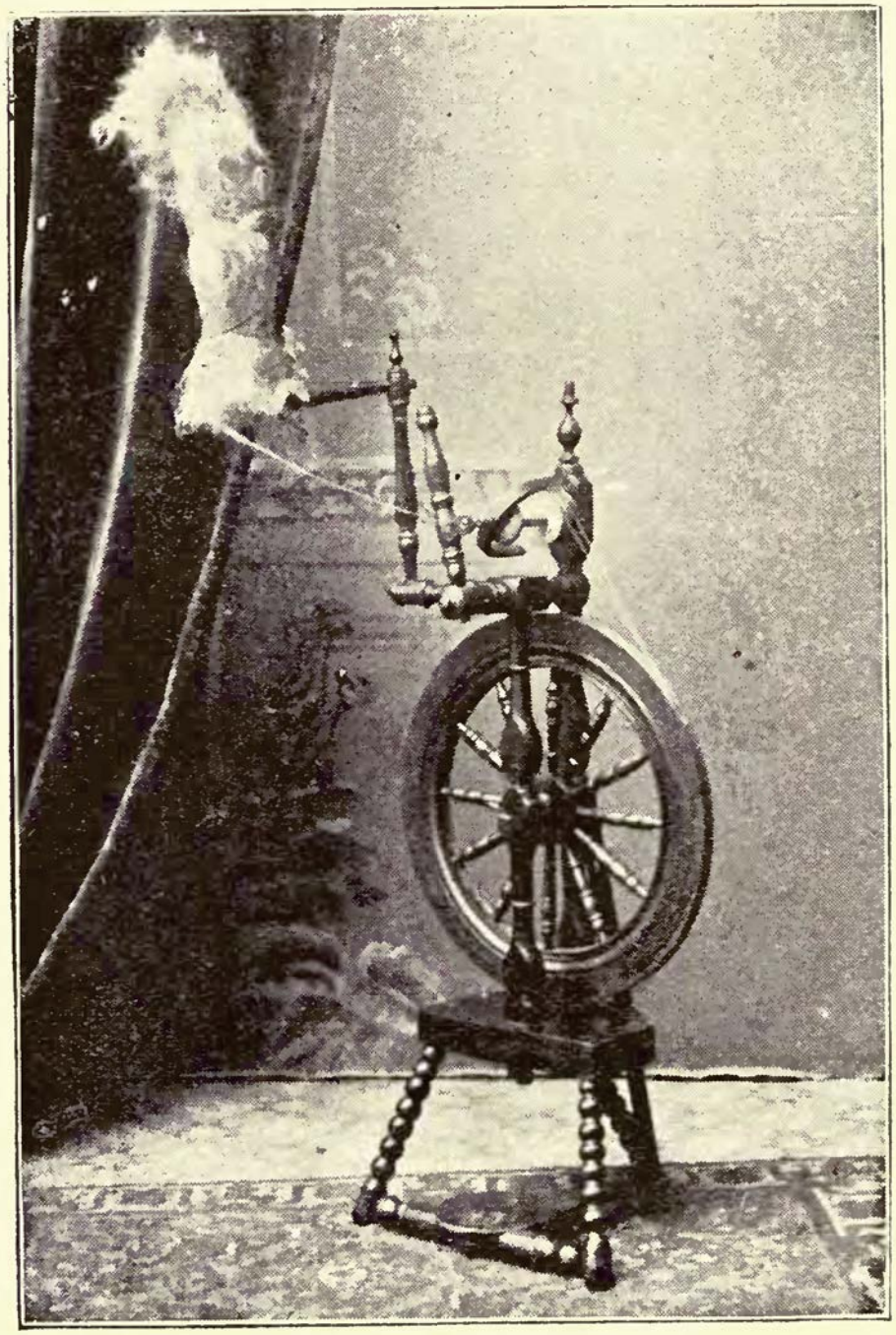
The first improvement on the primitive spinning implement appears to have been to place it in bearings, involving putting the spindle in a horizontal position, and having a belt and wheel as the means of causing it to rotate, the wheel being turned by the hand whenever the spinster was ready to put twist into the fibres. Velocity would be obtained in the revolution of the spindle by the endless cord placed round the hand-wheel and the pulley on the spindle. After this came the placing of a bobbin on the spindle upon which to wind the yarn. This kind of spinning device, the charka or

spinning-wheel of the East and the "muckle wheel" of Scotland, was known in Europe as early as the fourteenth century. It marked a definite advance on anything yet done, and the bobbin placed on the spindle foreshadowed important developments which were to follow centuries later.

So far all the processes had been controlled by hand, but the Brunswick wheel, which came into use near the middle of the sixteenth century, transferred the driving power to the feet by the introduction of the treadle, so giving continuous rotation and freeing the hands for other purposes. This wheel marks a considerable step in making spinning devices more effective and complex. It was followed by the Saxon wheel in which there was also a separate bobbin on the spindle to receive the yarn, and a remarkable addition to the spindle was the "flyer," consisting of two bent arms of the spindle for winding the yarn on to the bobbin. The spindle and the bobbin revolved at different rates of speed. Twist was given from the revolutions of the spindle, and the difference of rotation caused the winding on. By means of the series of teeth on the flyer the spinster could regulate the distribution of the yarn on the bobbin. The Saxon wheel sometimes had two spindles and bobbins a little apart from each other, the distaff with the fibres being elevated between them. Since on such a wheel two threads could be spun, it has been claimed that the two-spindled Saxon wheel marks the first successful effort in multiple production of yarn on one contrivance.

The Saxon wheel was invented somewhere about the middle of the sixteenth century. From that time till towards the end of the eighteenth century, when the age of mechanical power in the cotton industry arose, the spinning-wheel, in one or other of its forms, was the

basis of a great domestic industry, as well as being in use in innumerable cases for producing yarn for home



AN OLD FLAX WHEEL.

consumption. Even now in remote neighbourhoods one may find the spinning-wheel in use in our own country for the making of certain kinds of goods. One would not

like to think that it will ever completely disappear. It has figured in many romances ; it is often mentioned in our literature ; in some ways it suggests repose in the midst of useful labour and has, so to speak, an ideal household look about it. Within it were the germs of many later developments. A woman in these modern days at her sewing machine, with busy hands and busy feet, irresistibly recalls her great grandmothers at their household task.

In the sixteenth century the English spinsters used mainly a spinning-wheel of less advanced type than the Saxon wheel. It was a single-thread wheel supposed to have come into use near the end of the fifteenth century, in working which the spinster sat at one side of the wheel, having a basket of previously carded cotton on the floor. One writer, describing the working of this wheel, says that the carding process led to the combing out of the fibres in a primitive way, and afterwards two operations were necessary. "The first was to attach the carded cotton to the spindle and then by turning the wheel to draw it out into a slightly twisted cord, called a roving. This drawing out was accomplished by the spinster taking hold of the fibre with the finger and thumb of her left hand and at a point a few inches from the spindle. Then she turned the wheel with her right hand, so as to make the spindle revolve for twisting purposes, the while she drew the cotton in her hand gently backwards so as to give the due extension. When she had got the length of the line properly twisted and drawn she then, by a reverse movement of the wheel, wound up the roving on a spindle which was generally furnished with a spool or bobbin for this purpose. The roving thus prepared was then placed upon the spindle point and still further drawn out, twisted, and wound up in cop fashion."

SPINNING ON THE SAXON WHEEL.

On the wheels mentioned the English spinsters, prior to the era of cotton, spun the fibres of wool and flax, or mixtures of the two. In the sixteenth century cotton began to win its way, though its extended use was met with opposition, probably because it was a more difficult material for the spinsters to handle as far as the actual spinning was concerned, and because of vested interests in the case of the manufacturers. In the next century its growth as raw material for spinning became pronounced. About 1640, it was used in the manufacture of fustians and velveteens, and in 1697, there was very little short of 2,000,000 lbs. of cotton fibre among the importations of the country. And we know that three years later Parliament was taking action, not to prohibit the importation of the raw material, but that of the manufactures from it which were coming from India. Some of the hostility to the new raw material seems to have been justified on practical grounds, since it could not be spun, under the conditions of the day, into a thread strong enough to serve for warp. In these circumstances any fabric in which it was employed had to have a foundation of a stouter material such as flax. This condition of things seems to have continued right down to the invention of the water-frame by Arkwright.

CHAPTER VII

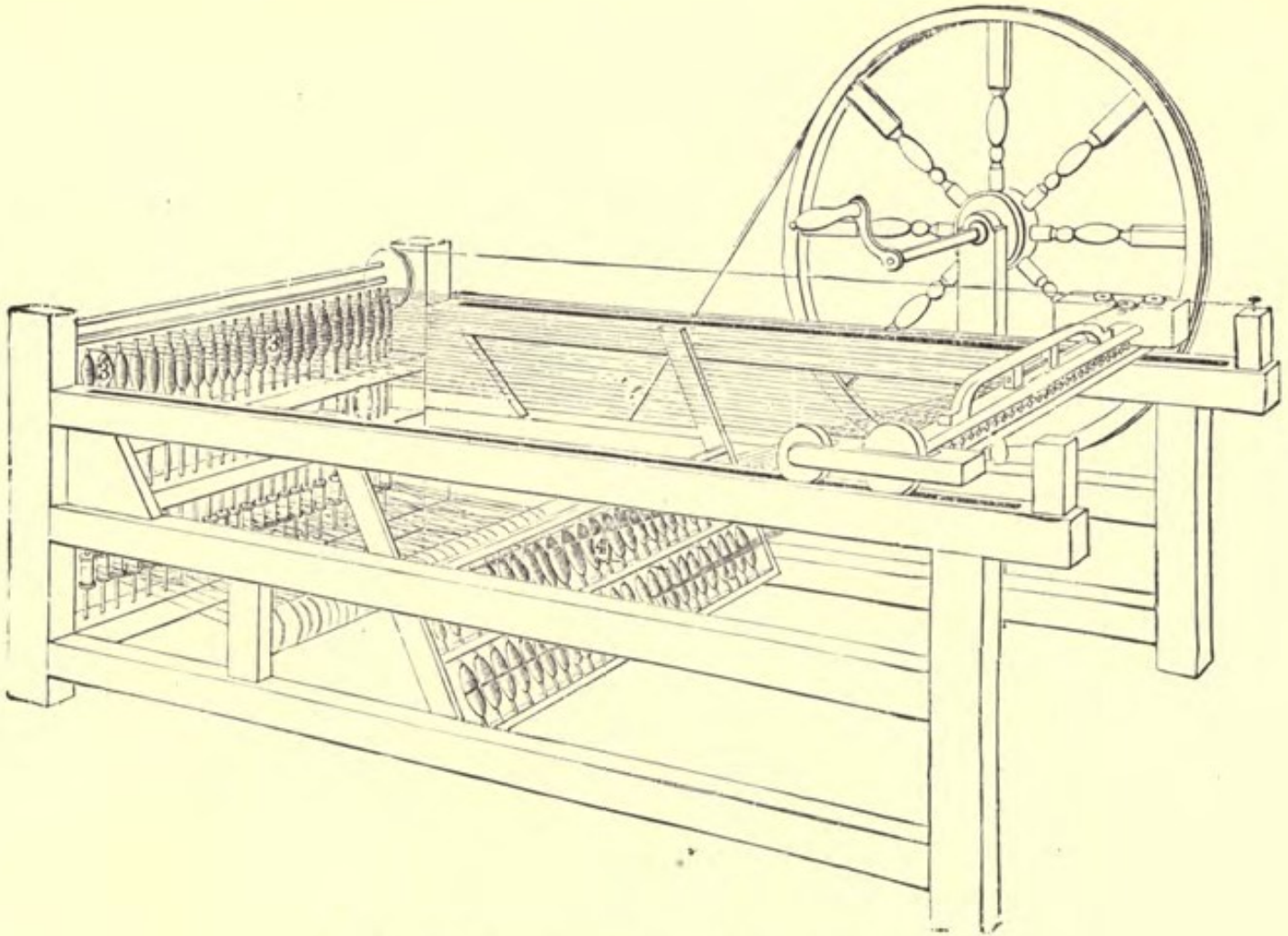
THE JENNY AND THE WATER FRAME

A STRIKING feature, which characterises inventions of cotton-spinning machinery, is the two distinct sets of lines upon which they have run. The first of these is an intermittent movement of spinning and winding up, seen first in the earliest use of the spindle, and continuing in the old spinning-wheel, most extensively used in England—the Jersey wheel—in Hargreaves's spinning jenny, and in Crompton's mule and its modern developments. The other type was the continuous spinning inaugurated by the Saxon wheel, with its treadle motion that freed the hands for the handling of the fibres, which method was extended by the inventions of Lewis Paul, Arkwright, and in the present day ring spinning machinery. Modern spinning thus embodies the two principles.

Mechanical spinning began its career in the eighteenth century, when all the existing conditions were such as to make a more rapid production of yarn indispensable. Even when both spinner and weaver had all their work to do by hand, the latter could absorb the product of several spinners. The weaver often had to make great exertions early in the morning to collect from spinners enough material to employ his loom for the rest of the day. But certain improvements of the loom by the inventor Kay, in the year 1733, had the effect of doubling the output of the hand-loom weaver and so of accentuating the demands upon the spinners, already unable to meet the calls upon their industry before the loom was rendered more productive. Every circumstance in the industry therefore tended to stimulate inventiveness

on the spinning side. It is, perhaps, necessary to point out that at the time wool was still the staple of these hand-wheels and looms, though cotton was gaining ground.

For the first invention of a spinning machine, credit is sometimes given to Lewis Paul and sometimes to his collaborator, John C. Wyatt. Paul was a druggist in London, a son of a French refugee ; Wyatt's home was in Birmingham. Either both conjointly, or one or other of them, did produce a machine which was upon principles followed later by Arkwright, and in its essentials foreshadowed modern spinning devices. Paul took out the patent, and according to his description of the machine, its purpose was, by successive pairs of rollers moving at accelerated speeds, to draw out a previously prepared roll-rope or sliver of wool. He contended that a thread could be drawn out to any degree of fineness required by the multiplication of the pairs of rollers, each pair moving proportionately faster than the first. In the spinning-frame, of which these rollers were part, the spindle and the bobbin placed upon it were each acted upon by toothed wheels so adjusted as to give different speeds—a principle copied from the Saxon wheel. The spindle was in a perpendicular position for the first time since it had been put into bearings. Ever since this has been accepted as the best position. As will be seen later, the next great spinning invention quite independently (there being no evidence that its author ever heard of the roller-spinning machine) embodied the idea of the upright spindle. Although efforts were made to work and popularise this invention—Dr. Johnson himself taking a part in recommending it to people in authority—it never established itself in public favour in the form it had been given by its inventor. The next spinning



HARGREAVES'S SPINNING JENNY.

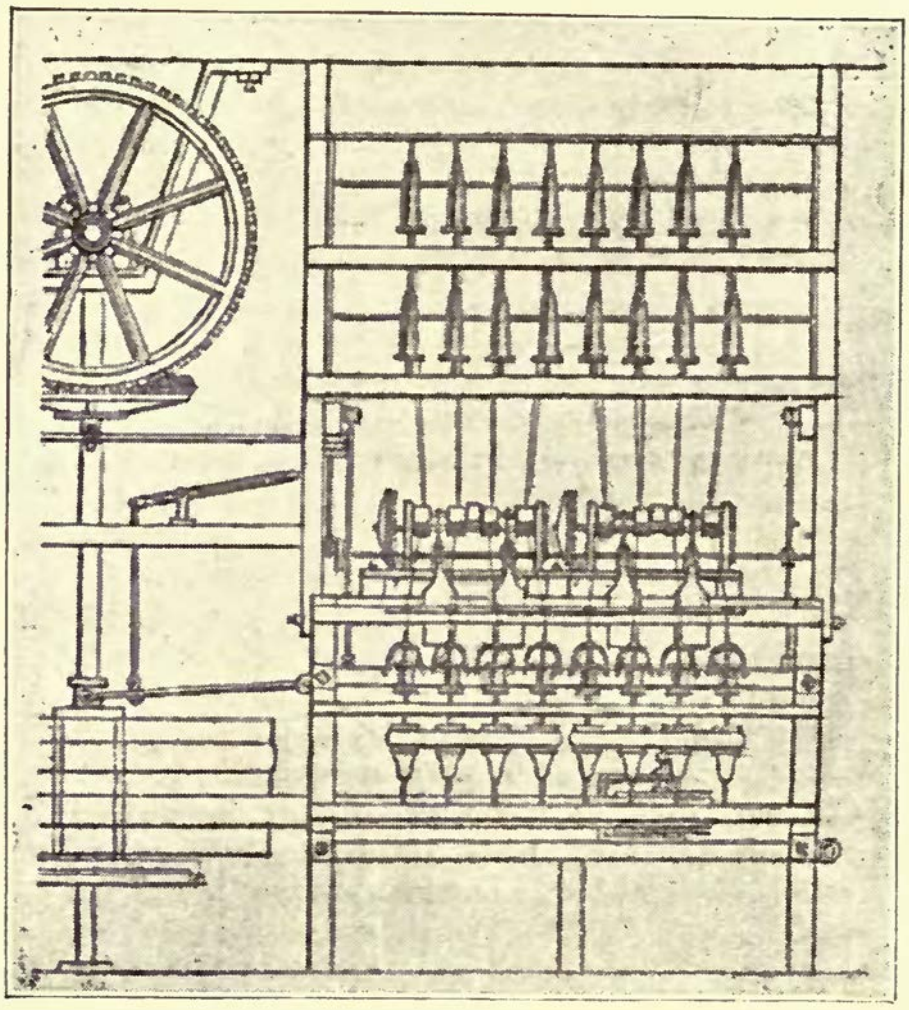
invention, that of James Hargreaves, met with a different fate. Born at Standhill, near Blackburn, in 1732, Hargreaves, whose trade was that of a carpenter with which he combined weaving, was a man of original qualities of mind. He called the machine he invented the spinning jenny. A rival claimant to the invention, after it had become popular, used this name as support for his case, saying he had called it after his daughter Jenny. But the name has a sound origin without that explanation. According to Webster and Skeat, " jenny" is really " gin," a contraction of engine, in a form which has been influenced by the proper name ; and many machines were called jennys in Hargreaves's time. The spinning-wheels which Hargreaves had known would carry their spindles in a horizontal position, but in the jenny they became vertical. Hargreaves himself told how he came to think of putting the spindle in that position. One of his children had knocked over a spinning-wheel and, when he saw the wheel continue to revolve on its side and the spindle to rotate in a perpendicular position, he conceived the idea of a machine in which spindles should be so placed in order to produce a number of threads at one time. After some experimental work, in which his skill as a carpenter was invaluable, Hargreaves constructed a machine capable of this achievement. It consisted of a frame of wood at one end of which eight spindles were placed in a row, with an endless band round a wharve on each and carried round a cylinder, which, receiving its own motion from the hand-wheel at the side of the frame, communicated it to the spindles which obtained a high velocity from the smallness of their wharves relatively to the cylinder. In a creel at a lower part of the frame, and at an angle which gave free passage of the thread, were eight bobbins or cops of rove, and across the top

of the frame, adapted to a sliding movement, were two bars or rails which could be made to press upon each other. The threads from the bobbins of rove were passed through grooves in one of the bars and attached to the spindles ; the bars were then closed upon each other and, while the threads were thus secured, the bars were moved along the frame, thus stretching the rove. Simultaneously the spinner would turn the hand wheel, causing the spindles to rotate, and so giving the requisite twist to the threads. After the sliding bars had been drawn along to the full length, the spindles were allowed to rotate for a short space to complete the twisting process. The spun threads were afterwards wound on the spindles by another twist of the handle, after a wire had been let down on to the threads to bring them into position. The jenny was an enormous advance in spinning machinery, inaugurating the era of multiplication of spindles under one control. Its invention came at a time when, owing to the greater demand for fabrics into which cotton entered and to inventions in connection with the loom, the production of spinners was falling into arrears. Five years before Hargreaves's invention, the Society of Arts advertised a reward of two prizes, the first of fifty and the second of twenty-five pounds, " for the best invention of a machine that will spin six threads of wool, flax, hemp or cotton at one time, and that will require but one person to attend it. Cheapness and simplicity in its construction will be considered part of its merit." Whether Hargreaves knew of this offer or not does not appear, but it is interesting as an indication of the demands of the times in which he must first have begun to apply his thoughts to the problem. Like other inventors of cotton machinery, Hargreaves met with hostility from those who should have recognised that he was their

benefactor. He missed the full benefit of his invention owing to his having forfeited patent rights by selling some of the machines before taking out a patent. He, however, did moderately well in business.

Hargreaves's invention, as we have seen, introduced mechanical spinning; Arkwright may be said to be the real founder of the factory system. Richard Arkwright, born at Preston, in 1732, went as a young man, then following the trade of barber, to Bolton, where he met with a watchmaker named Kay, who helped him in giving mechanical expression to his ideas. He travelled about a good deal among the old hand spinners and weavers, and during this time used a dyeing process of his own invention with great success. In his day, a man of inventive resource such as he must quite easily have seen what an opening there was for a better method of spinning. It was, indeed, only one year after his settling down in Bolton that the Society of Arts made their offer of a reward for a new spinning machine. Though himself ignorant of mechanics, he had a liberal endowment of ideas and energy, and was of so practical a turn of mind that we may be sure only a very sore need turned his attention to cotton-spinning improvements. In 1768, he brought out his spinning frame. It is said that Arkwright, knowing the trials Hargreaves had been subjected to, was unwilling to set his machine to work in Lancashire. He constructed the model secretly and apparently, until he needed monetary aid to produce an actual machine, guarded his invention well. There was actually nothing really new in its main features; on this ground he is denied the honour of being the first to make a machine capable of continuous spinning. But in the combination of various ideas, assuming that Arkwright knew others had tried them, there was an originality as great as was

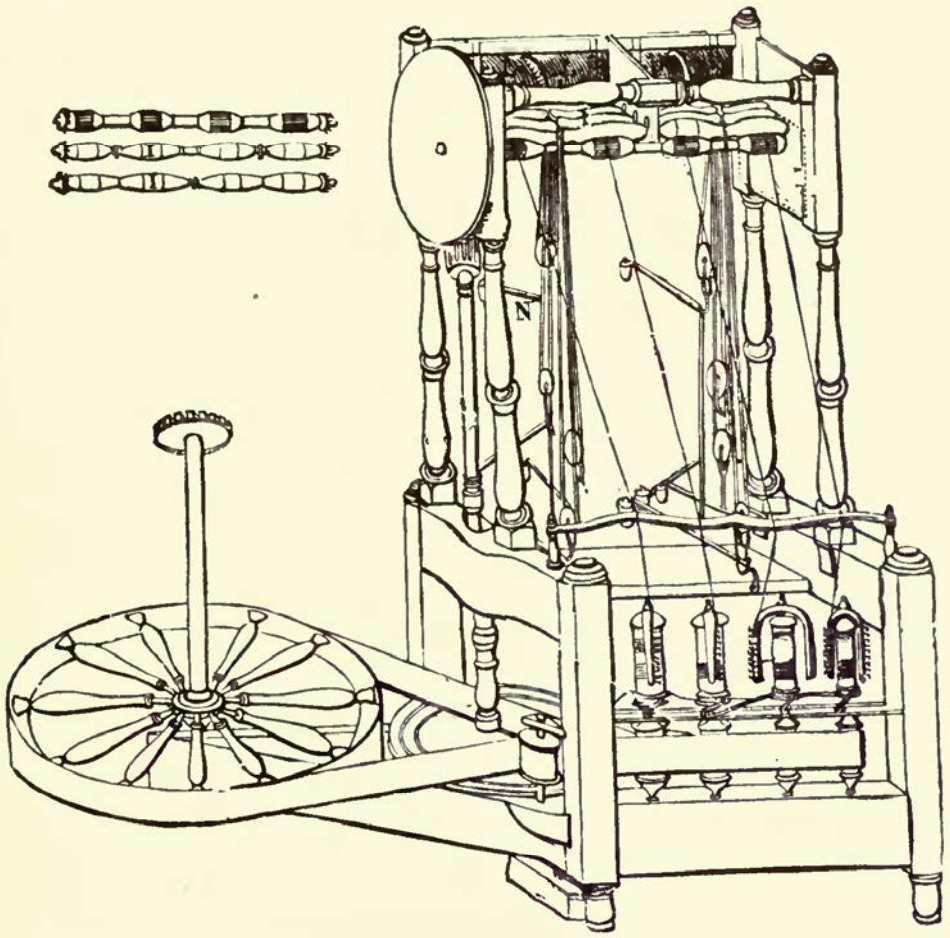
the inventiveness by which he surmounted difficulties which had been fatal to others. Up to his time, no invention capable of making a thread of sufficient fineness and strength to be used for warp had been



ARKWRIGHT'S WATER-TWIST FRAME.

produced. He surmounted the obstacles. He did so by applying rollers to spinning: in his frame there were two pairs, each roller and its fellow being in contact. The first pair moved slowly and passed the cotton on to the second pair whose revolutions were much more rapid, and in this way the cotton was drawn out to the

required fineness. This device had been clearly tried in the invention of Paul or Wyatt ; but Arkwright apparently did not gain his idea from that unsuccessful invention ; for he said that the first suggestion came to him from seeing iron bars, which had been made red



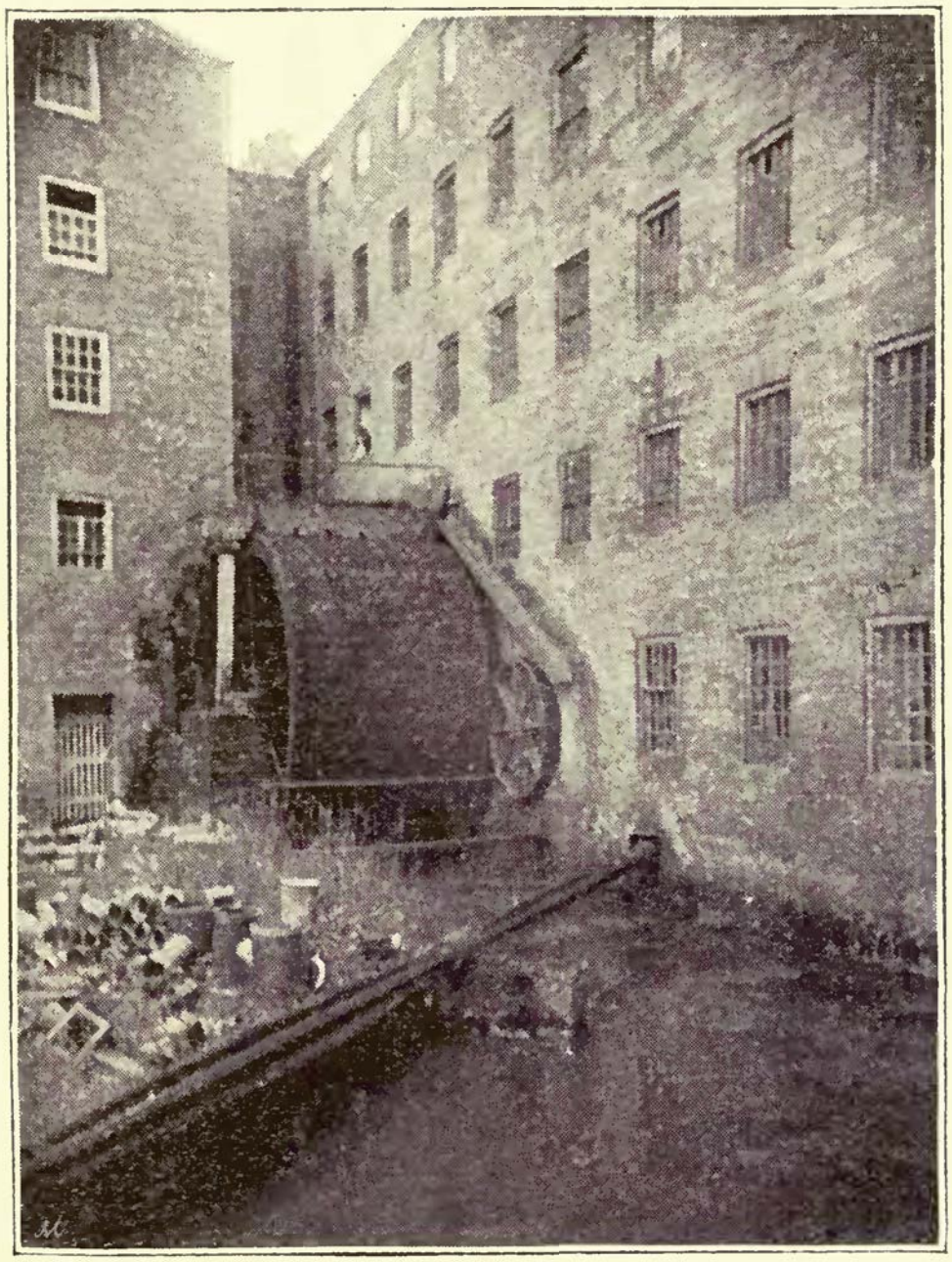
ARKWRIGHT'S ORIGINAL PATENT WATER FRAME.

hot, elongated by being put between rollers. The rollers were undoubtedly the newest principle in Arkwright's water-frame, which, however, had striking differences from Hargreaves's jenny. The framework itself was different, the roving was served from above to the spindles below, the reverse of Hargreaves's plan. Then the spindle on Arkwright's water-frame was a more complicated affair. The inventor copied the main

features of his spindle from that of the Saxony wheel. He gave the separate bobbins and the flyer, and the difference of rate of movement between these two parts that had first made continuous spinning possible. The power for the machine came from a horizontal wheel. After moving to Nottingham with his invention, and there establishing a partnership with Jedediah Strutt, the inventor of the stocking frame, and Samuel Need, Arkwright had mills built at Cromford and Matlock, and carried his contrivances further by the application of the water-wheel to the purposes of driving his machinery. He thus became the pioneer of the factory system, whose development has since been so astounding and of such tremendous consequence to the commercial position of this country.

The character of this original and enterprising man has often been appraised. Here, however tempting the subject, it would be a digression to attempt either to select from or to supplement these judgments. Suffice it to say that every known circumstance of his life indicates abounding commonsense and a fine practical ability. One can but regret that in his legal fight to secure the patent of his machine, the interests so easily led to league themselves against him should have proved victors after each had enjoyed periods of success in lower courts. Arrayed against him were fellow spinners, manufacturers, and his old assistant, the watchmaker Kay, to mention only part of the opposition he had to meet at various times. Military and police saw a large factory of his burnt down by his enemies, and no word to set them in action came from the magistrates. But Arkwright's energies were not stultified by these things, nor was his temper spoiled. Carlyle found him "a plain, almost gross, bag-cheeked, pot-bellied Lancashire man with an air of painful reflection, yet also

of copious predigestion." That description of his physical lineaments is true, if one adds that both eye



THE WATER WHEEL AT CROMFORD.

and chin spoke of his fixity of purpose and firm determination. He did not share the unkindly fate of some others among the early benefactors of the cotton

industry, such as Kay, the inventor of the fly shuttle, who died, poor and unrecognised, in France whither he had gone to get money to support his family and pay off his debts. On the contrary, Arkwright's troubles seem all to have cleared away in his later years, leaving his life almost unclouded : one of those rare instances in which Destiny does for a man what the novelist does for his hero and heroine. He never ceased to busy himself in improving the machine he had invented and in working out plans which would increase the output of his industry, among which was the introduction of the steam engine to drive the machinery in his works. Though his early labours seemed for a while to be proving vain and unprofitable, his reward in the end was not inconsiderable. Honoured by his adopted county by being made High Sheriff, by his King with Knighthood, he died at the age of sixty, leaving a fortune of half-a-million pounds.

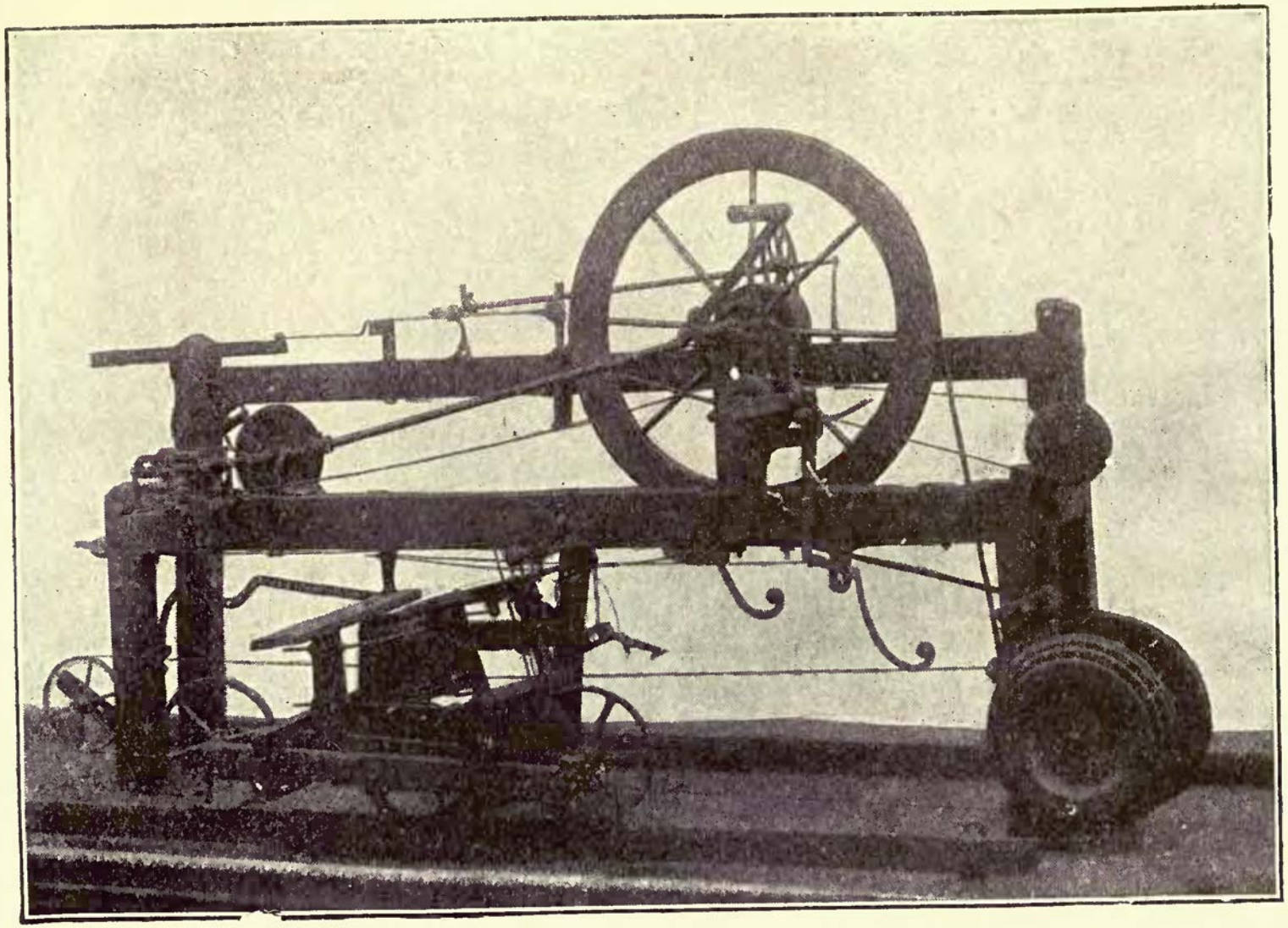
CHAPTER VIII

THE MULE AND THE RING FRAME

THE next great step in cotton-spinning inventions was that of Samuel Crompton. It is probable that the spinning mule was the most important advance ever made, and by it more than by any other invention has the industry been brought to the present high position. Crompton was the son of a farmer whose household, like many other of his day, added various activities in cotton manufacture to their agricultural pursuits. Bolton has just claims to be considered one of the most ancient cotton towns in the country, and at the time of Crompton's birth there—actually in the parish of Bolton, though Firwood Fold was about a mile outside the town—it was a centre for woollen goods into which cotton entered as weft. Many of the farmers were small manufacturers, who carried their agricultural produce and their woven goods to the market at one and the same time. Five years after Crompton's birth, in 1753, his father moved to an old house in the same district, Hall-i'-th-Wood, and died there shortly afterwards. When Crompton was eleven years of age Hargreaves's jenny was invented, and Arkwright's water-frame appeared when the boy was fifteen. About that time, or a little later, Crompton himself was using one of the former machines. It is not clear at what age he began to apply his mind to an improved machine, but interesting side-lights on his early history clearly show that from quite tender years he showed a keen desire for mechanical study and considerable inventive aptitude. The yarns he had to use as a weaver, for he wove the yarns he spun, were unsatisfactory to him,

and there is clear evidence that before his twentieth year he had begun to meditate upon a means for improving them. How many experiments he made, or what line his first efforts followed, is only to be conjectured. At any rate six years passed before he began to construct his mule. Of active, curious mind and great persistence of character, it is safe to assume that in these six years he had made many experiments and tried many expedients. All the time he devoted to this task was additional to a pretty full day's work. His biographer, Mr. Gilbert French, in his excellent account of the inventor's life, says that Crompton in his enthusiasm did not scruple to deprive himself of many of the usual hours of rest, and Crompton himself wrote that "though often baffled I as often renewed the attempt and at length succeeded to my utmost desire at the expense of every shilling I had in the world." The five or six years must, therefore, have been years of exceedingly strenuous toil, and one catches revealing echoes from them in Mr. French's words that "strange and unaccountable sounds were heard in the old hall at most untimely hours: lights were seen in unusual places; and a rumour became current that the place was haunted."

News in those days did not travel very swiftly, and there is evidence which shows that Crompton had no acquaintance with either Lewis Paul's or Arkwright's application of rollers to the drawing out of the thread. Like Arkwright, he seems to have been struck by the analogy of the action of rolling mills or metal, but as we know, applied to cotton, this was only part of the story and by no means the important part. The effect which could be secured by pressure alone was too insignificant. "Mr. Crompton's first suggestion," says Mr. John Kennedy, "was to introduce a pair of rollers,



CROMPTON'S MULE.

See page 86

viz., a top and bottom roller, which he expected to elongate the rove by pressure like the process by which metals are drawn out, and which he had observed in the wire-drawing for reeds used on the loom. In this he was disappointed, and afterwards adopted a second pair of rollers." At this stage he was led precisely to the same device as that which Arkwright and Paul or Wyatt had conceived, the two pairs of rollers working at different speeds. His original rollers were of wood covered by sheepskin. It was in the carriage of his mule that Crompton made his most individual and most valuable contribution to cotton machinery progress. Except in the movements in hand-spinning its action had been anticipated only once—in Hargreaves's jenny, and there in a relatively elementary fashion. Nothing vital has been added to Crompton's invention, which remains in all its essentials in the self-acting mule of to-day. How great an advance his mule was on Arkwright's water-frame can be seen in the single fact that, whereas the latter was capable of spinning a pound of cotton to a length of 19 miles, his machine could spin it to a length of 950 miles. But not only greater fineness but also greater evenness and strength in the yarn was achieved—so that all the qualities so much sought after in the cotton-spinning industry resulted from Crompton's efforts.

Because his machine combined the principles of Hargreaves's jenny and Arkwright's water-frame it came to be called "the mule." It went much farther, however, than is implied in this statement, and it was Crompton's individual genius which refined the ideas embodied in the other two machines and so applied them and improved them as to increase their usefulness a thousandfold. As we have said, the chief feature in his invention was the spindle carriage, and the important

difference in this part of his machine from the jenny was that the spindles, instead of being in the fixed frame as in Hargreaves's invention, were placed in the movable carriage. Crompton by this device delayed the strain being put upon the thread until it was fortified to receive it. His rollers "paid out" the roving and secured a partial drawing out before stopping and clasping the thread, as did the hand clasp on Hargreaves's jenny. The spindle carriage moved afterwards to give the additional stretch, but by this time the thread had been strengthened by twisting, the attenuated parts being made even with the rest in the process. It was here that Crompton's greatest success was achieved, for it was by these means that he was able to give the world a smoother, finer and stronger yarn. Altogether, the first mule was a machine of astonishing ingenuity in its details as well as in its central principles. On his first mule he placed only about twenty or thirty spindles, but this number was soon increased. The only one of his mules now remaining in existence, which, appropriately enough, is in Bolton, his native place, had originally fifty spindles. The machine consists of drawing-rollers, spindle-carriage, headstock and driving-wheel and the necessary wheels and belts. By the one driving-wheel all the necessary motions could be obtained. The remarkable success of the machine in Crompton's lifetime shows how truly he had met a great industrial need. Four years after he completed his first mule there were, according to a reliable estimate, not more than 1,000 spindles on his system at work. Eleven years after, in 1790, that is, water-power was applied to the mule as it had been to Arkwright's frame. With this change came the transformation of the mule from a hand-worked to a power-worked machine, and its transference from cottage to factory. Mills sprang

up upon watercourses, and hand-spinning in the home began its descent into extinction. Woman spinners, unable to work the mules when they grew heavier, were replaced by men, and so the era of mechanical cotton spinning as a male occupation began its course. Following water power driving came the doubling of the mule and multiplication of the number of spindles under the superintendence of one spinner. Then came, towards the end of the eighteenth century, the more extensive application of the steam engine to cotton spinning mills, which meant a further growth of the industry. By 1810 a vast development had taken place. Crompton's machine had outstripped its competitors handsomely. Its special feature, that of its capacity to spin fine yarns, had opened up and widened new avenues for cotton-spinning enterprise, and these had been used to great profit. In the year named, Crompton was able to say "the number of spindles used upon Hargreaves's jenny was 155,810; upon Arkwright's water-frames, 310,516; upon Crompton's mules, 4,600,000." Thus, 31 years after he constructed his first mule his invention was far ahead of all possibility of rivalry. He had undoubtedly given a new value to the cotton industry, and had made perhaps the greatest single contribution of his age to the commercial prosperity of the nation.

It is not a pleasing task to turn from the aspect side of Crompton's achievement to the attitude which the people of his day took towards it; but it is necessary that the facts should be given, quite briefly, showing how, like other cotton industry inventors, he suffered at the hands of the people whom he designed to benefit. His completion of the mule came just after an outburst of machine-breaking violence on the part of Lancashire rioters, in which almost all the jennys in Blackburn

and five miles round had been smashed. Crompton himself, during his experiments, heard some such demonstrations in his own immediate district and hurriedly packed up and concealed his precious model fearing the destroyers might reach his home. Hidden in a garret the precious treasure lay for many weeks before he dared to put the pieces together again. When it was safe to do so, he assembled the parts again and completed his machine, upon which he was soon able to spin muslins of an exceedingly delicate texture. His biographer tells us that the fame of his yarns, of a fineness and firmness hitherto unheard of, soon spread, notwithstanding the fact that he spun them in secret at the Hall after going, on his marriage, in 1790, to live elsewhere. Something of the trials which the public discovery of his achievements created is shown by the following passage in Mr. French's biography—

> The demand for the new yarn was so extensive and so urgent that the supply could not satisfy one-hundredth part of it, and daily and hourly the demand increased. The consequence was that the old Hall was besieged by manufacturers and others from the surrounding districts—many of whom came to purchase yarn, but many more prepared to penetrate the mystery of the wonderful new wheel and to discover the principle of its operations by any means in their power. All kinds of stratagems were practised to obtain admission to the house; and when this was denied many climbed up to the windows outside by the aid of harrows and ladders to look in at the machine. Crompton erected a screen to protect himself from this kind of observation, but even that did not at all times serve the intended purpose. One inquisitive adventurer is said to have ensconced himself for some days in the cockloft where he watched Samuel at work through a gimlet-hole pierced through the ceiling.

Crompton had not the money to apply for a patent, yet the annoyance and intense curiosity of the cotton world made it impossible to contemplate secrecy any longer. "A few months," he wrote, "reduced me to the cruel necessity of destroying my machine altogether

or giving it up to the public. Destroy it I could not ; to give up that for which I had laboured so long was cruel. I had no patent nor the means of purchasing one. In preference to destroying it I gave it to the public." Promises were made that he would be rewarded with a subscription from the purses of neighbouring cotton manufacturers if he revealed his secret, but they proved delusive. The amount he received is variously placed at £50, £100 and £106, while he himself stated that the total was only sufficient to build him a new machine with fifty-two spindles, four more than there were on the one he gave up. That was in 1780. By this time the men who had promised the subscription were fully alive to the great utility of his invention, and their bad faith and extreme lack of fair play, not to say generosity, is not to be explained by anything short of sheer meanness. Yet neither meanness nor a disposition to deny a man a square deal is characteristic of either the county or the industry which Crompton enriched, and one would like to have all the collateral evidence before agreeing in full with the bitter verdicts that have been passed in connection with this incident. Many a good cause has suffered through the interposition of disturbing events, through the absence of energetic organisation, or a misunderstanding as to the measure of its deservedness. A search over the records of this period of Crompton's life, and over the history of the cotton industry, does not yield any full explanation of why the promise was carried out in a niggardly spirit. But it is fair to the men whose action one cannot but condemn to say that at that day a sum of £200 would perhaps have been regarded as a reasonable one in such a matter, and that we of this day find our view of the whole episode rendered out of balance by our knowledge of

what the mule afterwards became. If £100 was realised, there would doubtless be among the subscribers some who would believe, in the circumstances then prevailing, that the reward was adequate, and that fact must be borne in mind when we are forming a judgment on the circumstances. We must also remember that even three years after this date Crompton's mules were not in use to any greater extent than 1,000 spindles, so that the area over which actual profit from his invention had spread could not have been a large one at the time the money was handed over to him. And as it is true that many proved defaulters from their promises, while that is to their infinite discredit, it is by the same reasoning greatly to the enhancement of the credit of some others who must have done, proportionately to their means and, considering the views held in regard to such matters at that particular time, moderately well. Yet one does not here endeavour to extenuate too greatly the fault of those early cotton men, but simply to see all the circumstances from the point of view of the year 1780, and seek whatever mitigation there is in seeing the matter from that angle.

After its presentation to the public, the muslin-wheel was much improved by minor inventions by people who came to work it. A mechanic who lived in the Bolton district, Henry Stones, introduced metal rollers in place of Crompton's wooden ones and also a device for stopping the rollers automatically when they had given out a sufficient length of roving. Other workers on the mule made additions to its mechanism. A Stockport man brought out and was rewarded for a machine called the "billy," which was a combination of the mule and the jenny and was applied to the making of carded cotton into rovings, work which, since Crompton's mule was used only for the spinning of yarn, had

been very largely the distinctive business of Arkwright's carding and roving machines. The billy filled a great gap, reducing costs and proving quite adaptable to the production of suitable rovings for all the existing types of spinning machines. Many of the new ideas applied to Crompton's mule itself by operatives who worked it led to the multiplication of the number of spindles and therefore increased its value. Crompton saw his invention grow in usefulness and in the extent to which it was used until it became clear that no other spinning invention could rival it ; and he saw all this without himself realising any appreciable benefit from the work of his laborious youth and early manhood. A comparison of the amount of raw cotton imported at this period shows to what extent the cotton industry had been stimulated by the various inventions which had come into use. In 1779, the year when he completed his mule, the import was 6,000,000 lbs. Six years later it was three times that quantity. In 1790 it was 31,000,000 lbs., and in 1800 it was 46,000,000 lbs. By the opening of the nineteenth century the mule had come to have about 200 spindles and its capacity in every way had been developed. How many mules were then in use is conjectural, but we know that ten years later there were over 4,500,000 mule spindles. It is not improbable that about 3,000,000 had come into use in the period over which the astonishing growth of the importation of raw cotton took place.

In the year 1803 Crompton was himself carrying on a small manufactory in King-Street, Bolton, where he employed three men, one woman, and six children. Some time before this a group of Manchester gentlemen, "sensible that he had been ill used and neglected," promoted a second subscription for Crompton ; and if the surmise as to the extent of the growth of the mule

spindles in the later years of the eighteenth century be correct, it would by this time have become clear to everybody in the Lancashire industry that Crompton had received very poor treatment indeed from those he had benefited. Again, there is a difference in the records of what was the amount raised, but it is usually accepted that it was about £500. The unsettled state of the nation's affairs at the time probably interfered with a bigger sum being realised. The years which followed did not bring any success to the inventor in business, and his mind dwelt more and more on his claim for some commensurate financial recognition of the services he had rendered. Crompton prepared a record of the number of spindles working on his mules, and in 1811 a petition was presented to Parliament, praying for recognition of his services to the public and the State. It is on record that he thought himself entitled to a grant of £50,000. The sum ultimately granted him in May, 1812, was one-tenth of that figure. Crompton, it is said, would have received £20,000 had not Mr. Perceval, the Premier, who had intimated his intention of proposing that amount as a grant, been assassinated in the Lobby of the House of Commons when on his way to submit the proposition to the House. Crompton commenced bleaching with the money granted to him ; but with no more success than had attended his other commercial operations. During the last three years of his life—he died in June, 1827, at the age of 74—he lived on an annuity of £63 provided by some friends in his native town. A bronze statue was erected to his memory in his native town in 1862.

The mule was essentially a hand-wheel, as we have seen, and the application of power to drive spinning machinery had already taken place before it appeared. In the last fifteen years of the eighteenth century,

however, the factory system had its first considerable development and took firm hold of the cotton industry. Judging both by the very rapid growth of raw cotton imports and by the extended use of the steam engine and the multiplication of spinning machinery, we see in this period the actual foundation of to-day's great cotton-spinning industry. All that had preceded that period had been preparatory, the construction of the underground works ; the real edifice threw up its main walls in those years. Spinning machinery did not progress unopposed during that space : there were periodical machine-breaking raids and there were hand-spinners—such as the famous women of Mellor—who, while they disapproved of any riotous proceedings, declared that the new machines ought to be ordered by the Government " to cease working to the ruin of all His Majesty's loyal and dutiful spinsters in his dominions," and declared " they would never surrender a right which had descended to them from the earliest period of time and till now had never been disputed "—the right, that is, to use the hand-wheel. Improvements in the steam engine opened up prospects of cheaper working of cotton mills, but it was realised that before the best results could be achieved the hand control exercised by the spinner would need to be substituted by mechanical means. It was this need which gave rise to the self-acting mule. The need was made almost paramount by the coming of the power loom. Just as the invention of the fly shuttle by Kay increased the output of the weaver and caused the demand for a spinning machine having a multiple spindleage, so the Rev. Edward Cartwright's new loom redressed the threatened preponderance of spinning output, due to the high production of new inventions, and enabled the weaver once more to use more yarn than the spinners

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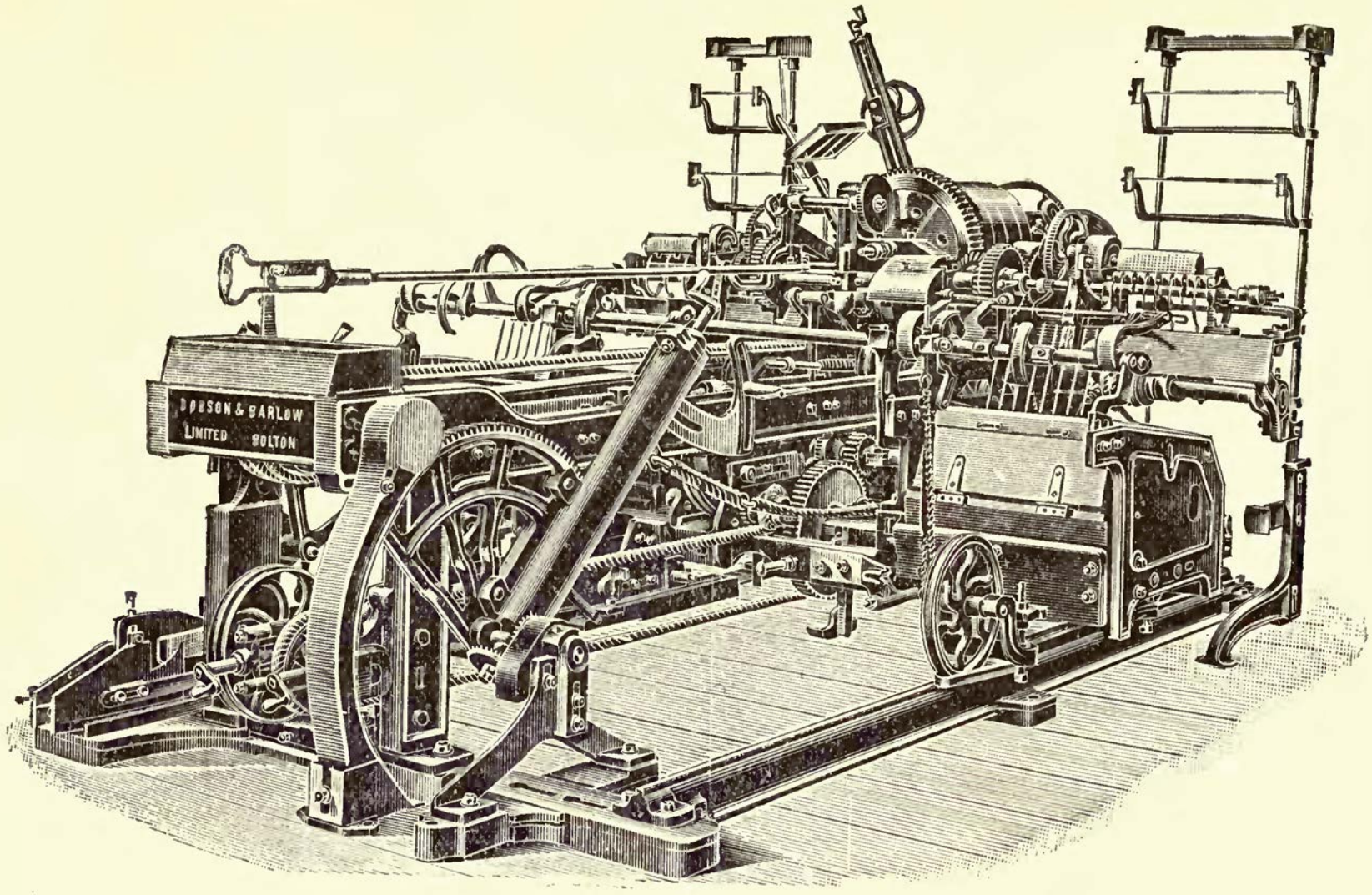

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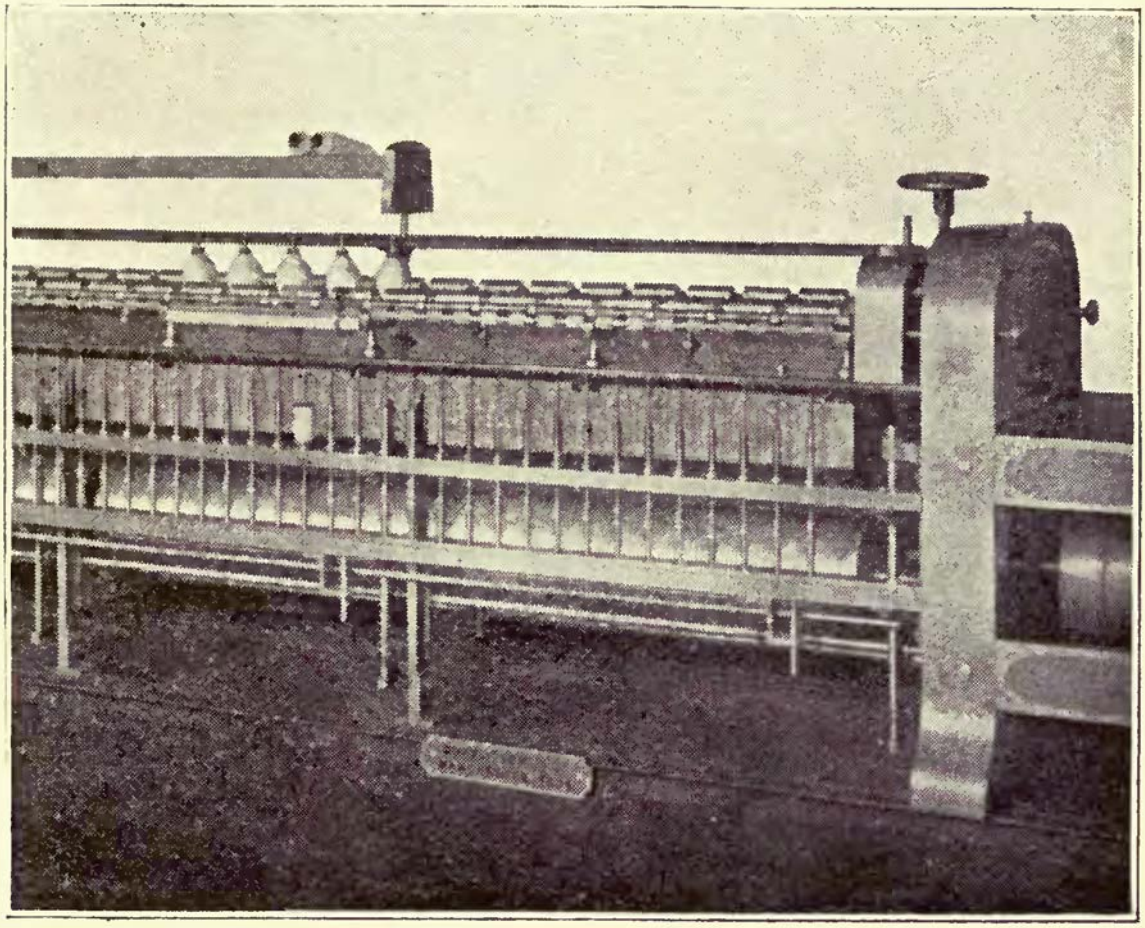
SELF-ACTING MULE.

could supply. Hence there began many efforts on the part of inventors to improve the mule in such a way as to make it self-acting—"to enable it to be worked by power without requiring the usual application of the strength of the spinners to give motion to the handles or wheels or to such other parts as are commonly worked by the strength of the spinners." There were innumerable difficulties in doing this, and the earliest self-acting mules proved failures. Richard Roberts, a Welshman, who had an engineering works in Manchester, finally overcame them all; his improved self-acting mule being patented in 1830. This great engineer, curiously enough, had to be stimulated by outside influences to take up this particular work. The late Sir W. H. Bailey, another well-known Manchester engineer, tells how at first he turned a deaf ear to entreaties of cotton spinners that he should help them by producing a spinning machine which would enable them to keep level with the consumption of the power loom. At length "he directed a Crompton's hand mule to be erected in the works so that he might familiarise himself with its motions and study how to construct one that should work automatically. The result we know. The new machine was immediately adopted by the Lancashire spinners; and in 1834 more than sixty mills, employing nearly 400,000 spindles, had the invention at work." No vital difference was imported into the mule in this later transformation, probably because in principle the mule represents the last word in spinning machinery. Crompton's invention itself perpetuated motions, as we have seen, which were all performed in the days of the most primitive hand-spinning. The self-acting mule made it possible to do these things on a very large scale without the aid of the human hand except in control and correction.

But this is not to deny but rather to affirm that, as a well-known authority has said, the invention of the self-acting mule was one of the greatest triumphs of mechanical genius. Like all cotton machinery inventions it has been constantly improved as better devices



A THROSTLE FRAME.

have suggested themselves, and to-day is almost human in the seeming intelligence with which it works.

Ring-spinning developments have resulted in the present ring-frame, which is a wonderfully efficient machine though not adapted to the finer classes of work. Between Arkwright's water-frame and the ring-frame, there was the throstle-frame, so called because of the

singing of its bobbins and spindles in their revolutions. The ring-frame was brought out in America just after the invention of the self-acting mule. It did not gain any popularity when introduced to this country shortly afterwards; but forty years later its manufacture here was taken up by a Manchester engineer, and since then it has gained in popularity here and has come to be widely used on the Continent. The ring-frame is a continuous spinner. In it the spindle—which in the mule is a simple iron rod with a wharve on it—reaches its most complicated form.

CHAPTER IX

THE MODERN SPINNING-MILL

COTTON spinning is, as we have seen, the operation of making a continuous thread from the fluffy material given by the cotton plant. Of the differences which exist in the raw material most people have a working notion. These initial differences, which, of course, determine the use to which the particular kinds of raw material can be put, are very numerous, and some of them are beyond men's control. The best raw cotton is that which has long staple, with very little variation between the fibres in length, diameter, and strength. The cotton-spinning expert has a whole list of other requirements to exact, such as tractability of staple, good colour, lustre, a sufficiency of helical twistings. The cotton fibre has the appearance of a flattened hosepipe which has been twisted, and this fact is of great consequence in spinning. A good many efforts to find a cotton substitute have been made and some very alluring materials have been offered ; one of the best, having an Eastern grass as its basis, was largely experimented with in 1920. In all cases the lack of spiral twistings has been considered a great drawback. It may, indeed, be said that nothing that will just serve the place of cotton has ever been discovered because of its possession of such qualities as that referred to, combined with its strength, beautiful lustre in its richest qualities, its softness, its responsiveness to dyes and to finish, and so forth. There are cotton spinners who say that no good substitute for cotton ever will be discovered ; that it is a thing of itself, existing only once in the whole realm of Nature. No doubt, this is

the shoemaker's "nothing like leather" in another form; but there are cases where the belief has carried men off their feet, as, for instance, in the following passage from an American author—

> What a royal plant it is! The world waits in attendance on its growth. The shower that falls whispering on its leaves is heard round the earth. The sun that shines on it is tempered by the prayers of all people. The frost that chills it and the dew that descends from the stars is noted and the trespass of a little worm on its green leaf is more to England than the advance of the Russian Army on her Asian outposts. It is gold from the instant it puts forth its tiny shoot. Its fibre is current in every bank; and, when loosing its fleeces to the sun it floats a sunny banner that glorifies the field of the humble farmer, that man is marshalled under a flag that will compel the allegiance of the world and wring a subsidy from every nation on the earth. It is the heritage that God gave to these people for their own forever when He arched our skies, established our mountains, girt us about with the ocean, loosed the breezes, tempered the sunshine and measured the rain. Ours and our children's for ever. As princely a talent as ever came from His hand to mortal stewardship.

It is as difficult to imagine anyone writing such a passage about the raw material of any other industry as to imagine the author of it being of any other nation.

The table shown on the next page gives a ready view of various qualities of cotton and their length of staple.

Most of the Sea Island, Egyptian and other grades of the finer, long-stapled cotton goes to the mills in the Bolton district and Manchester—long pre-eminent for fine spinning—while Oldham and South-East Lancashire take the bulk of the American and other shorter-stapled grades. The distribution of fine and coarse and medium spinning used to overlap but very little, but of late years there has been a growth of fine spinning in Oldham. Other cotton towns not noted for this section of the industry, such as Preston, have taken up some fine spinning. In the trade, however, one still hears the expressions "Bolton counts" and

"Oldham counts," which convey the distinction between finely spun yarns and medium and coarse yarns. Fine spinning is a term for counts of 50 and upwards. The medium and coarse yarns come below this count. The "counting" is based upon the number of times a given length of yarn—840 yds., known as a hank—occurs in a given weight, 1 lb. On

Quality.	*Place of Growth.*	*Staple.*
Best Sea Island	Islands, South Carolina, and West Indies	2″ and over
2nd Grade Sea Island	Florida, Georgia, and West Indies	$1\frac{1}{2}$″ to $1\frac{3}{4}$″
Best Egyptian	Egvpt	$1\frac{1}{2}$″ to $1\frac{3}{4}$″
Ord. Egyptian	Egypt and Sudan	$1\frac{1}{4}$″ to $1\frac{1}{2}$″
Best American	Mississippi, Delta, etc.	$1\frac{1}{4}$″ to $1\frac{1}{2}$″
,,	Nyasaland, Uganda, East and South Africa,	$1\frac{1}{8}$″ to $1\frac{1}{4}$″
Peruvian	Peru	1″ to $1\frac{1}{2}$″
Ord. American	U.S. and Mexico	1″ to $1\frac{1}{8}$″
,,	Brazil	$\frac{3}{4}$″ to $1\frac{1}{4}$″
,,	Russia	$\frac{7}{8}$″ to $1\frac{1}{8}$″
,,	West Africa	1″ to $1\frac{1}{8}$″
,,	Levant	$\frac{3}{4}$″ to $1\frac{1}{8}$″
,,	India	1″
	China and Korea	1″
Indian	India, Russia, and China	$\frac{3}{8}$ up.

this system, if 840 lbs. of the yarn were to weigh exactly 1 lb., the count of that yarn would be 1. From this it will be seen that 50's are yarns of which it takes 840 yds. × 50 to make 1 lb. The bulk of our fine spinning ranges from 50's to 140's, though there is a not inconsiderable amount of spinning of yarns above 140's and up to 300's. It will give some notion of the extreme tenuity of the thread of the 300's counts to say that a pound of it would stretch over 140 miles. Bolton's 9,500,000 mule spindles are very largely devoted to fine spinning, and it is the proud claim of the town that

nowhere else in the world can work of such delicacy be turned out in commercial quantities. There are some remarkable instances of extraordinarily fine spinning in tests of the possibilities of machinery ; up to 10,000's has once been spun, a pound of which would reach 4,776 miles. A yarn so fine that it would be 180 miles to the pound has not only been spun but woven. The fine yarns normally spun are used in the manufacture of nainsooks, tulles, muslins, laces and so forth. It is, indeed, one of the post-war possibilities that cotton will go more and more into the manufacture of the most delicate fabrics ; but not only the fine spinning but the medium and even some of the coarse is becoming, probably because of high wool prices, more and more in demand for clothing in Western Europe. It is only since the war that the fashion experts in leading newspapers have turned their attention to cotton for dress materials. Yet in a paper writing for a fairly exclusive circulation—the *Daily Telegraph*—the following remarks appeared in September, 1920 : " Cotton dresses for everyday wear should have a great vogue during the autumn, not because of the lower price alone, but actually because cottons are being made of more substance than hitherto, and readily take the place of wool. Cotton serges are being made, dyed with the fastest possible dyes, and the goods do not shrink one iota in the washing whilst ironing actually improves them."

It would be impossible in the space available here to deal specifically with the differences of treatment given to the raw material according to the kind of product that is desired. The many processes in the modern spinning-mill are highly specialised, but except for the very earliest of them they may all be said to converge upon the making of a continuous thread. There are several sections of the mill through which the cotton

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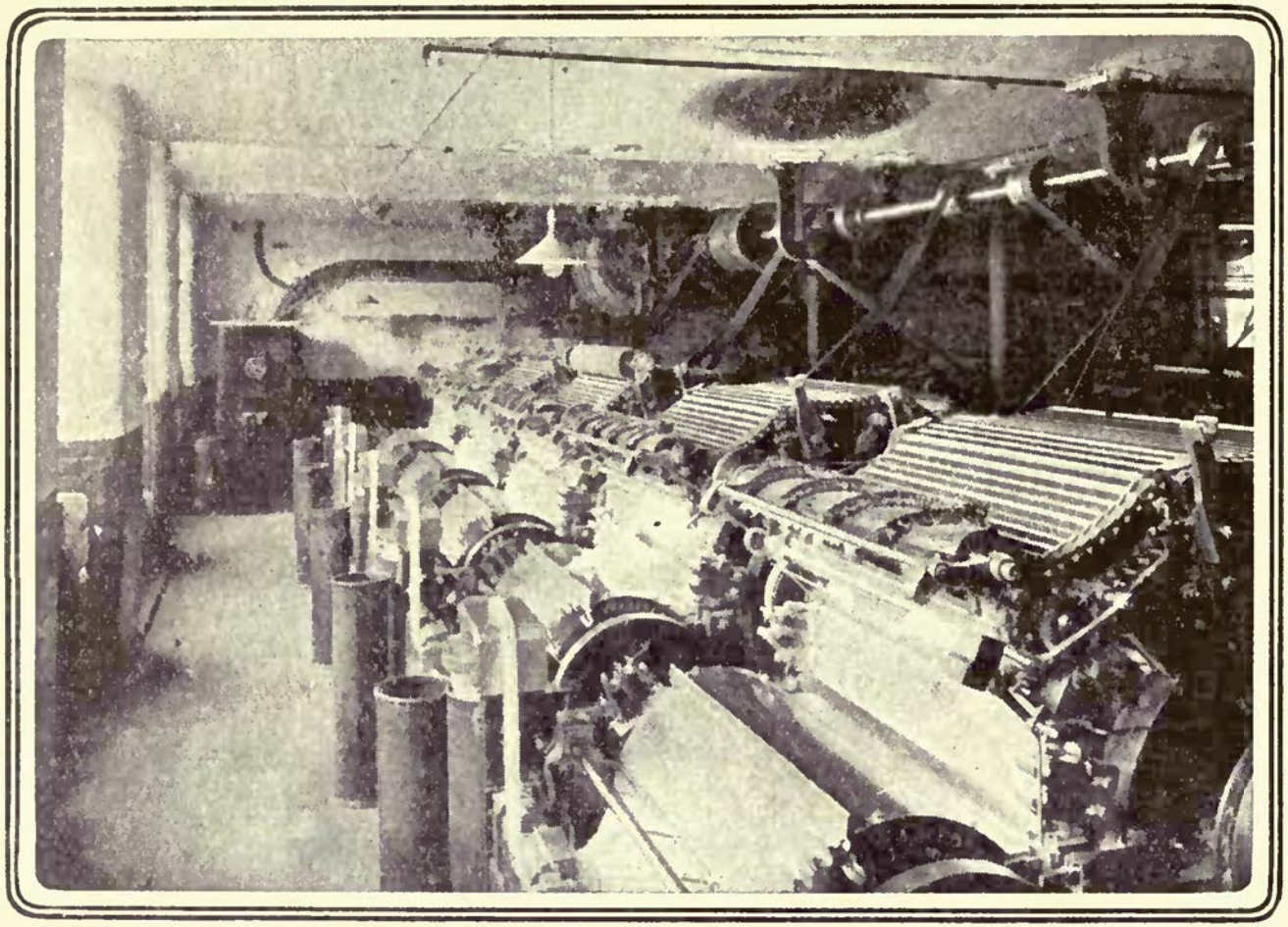
MIXING.

from the bale passes, the principal ones being the blowing-room, the card-room and the spinning room. The aim in the processes is to cleanse the fibres from extraneous matter, there being a great deal of dirt in the cotton as it is delivered to the spinning mill ; to lay the fibres side by side in a level, parallel order ; to pull them out into a sliver ; to draw out the sliver to a sufficient extent ; and finally to spin the rovings thus obtained into a yarn. All the processes involved, together with the machines used, are fully described in the book on *Cotton* in this series, by Mr. R. J. Peake. Here we need deal only with their purposes. It will be understood that there are mixing processes, sometimes done by hand, in order to get the quality of cotton yarn intended. Certain definite formulae are in use for these mixings. For instance, for under 50's twist of first-class quality a good mixture is Good Fair Brown Egyptian or higher grades of American, mixed with not more than one-third Maranhams, Santos, Pernams. These processes belong entirely to the technical side of the industry and we need only mention them : for the rest we will glance at the treatment on general lines of American cotton after it reaches the spinning-mill. The raw cotton from the bales requires cleaning and opening, and the latter process is sometimes rather prolonged owing to the high density packing of the bales. The cleaning and opening, mixing (which is dispensed with where only one class of cotton is used in the mill), further cleaning and opening and forming of the cotton into a lap are done in a series of machines, which, by mechanical and pneumatic action, finally produce a lap in which the fibres are not yet parallel and which has no tensile strength. From this point the processes are adapted to the forming of a continuous thread from the fully cleansed and opened cotton. It may be

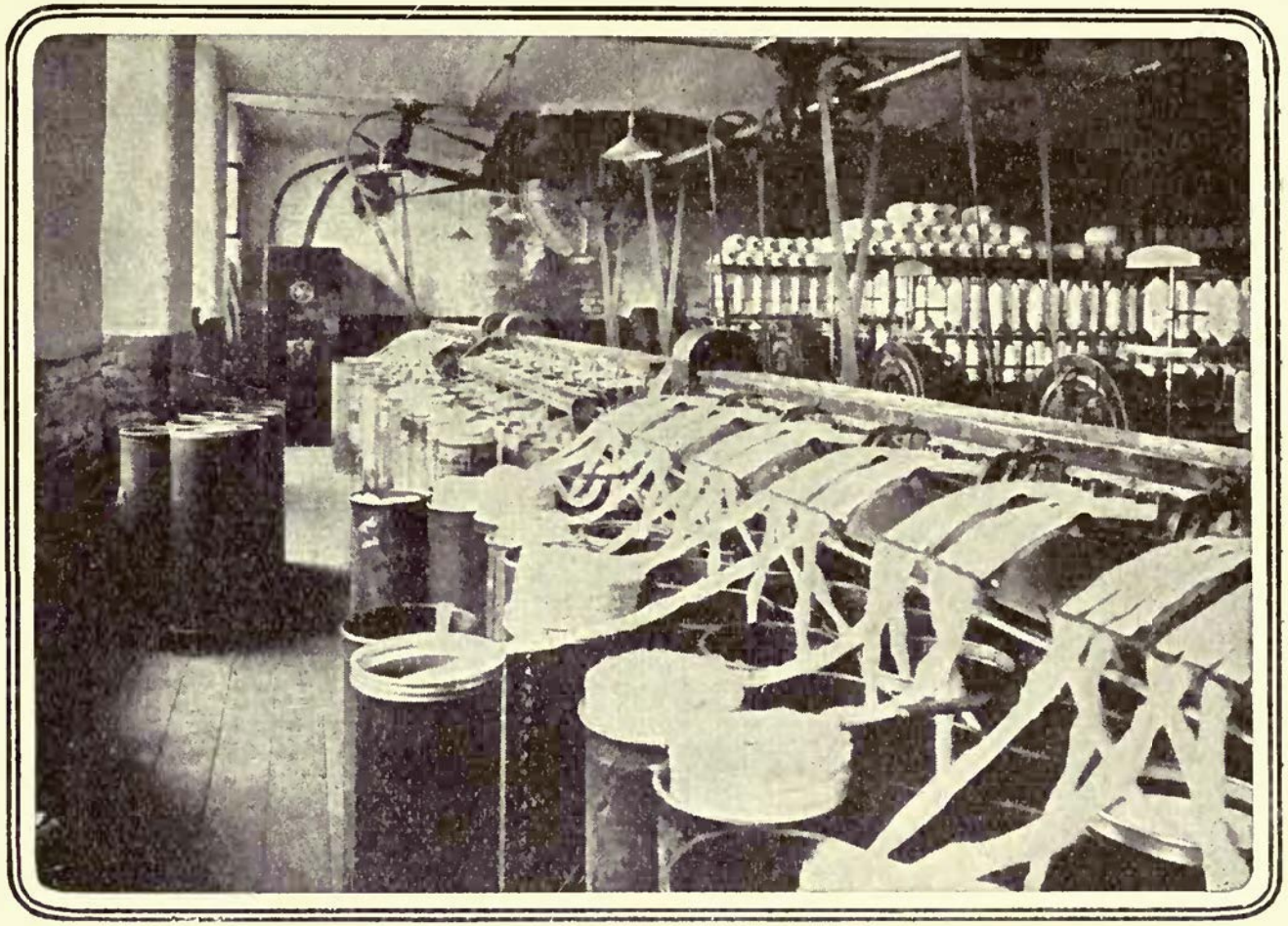


CARD ROOM

said that this is the point at which spinning actually begins ; for so far all operations have been directed to cleaning and opening the cotton and forming it into a convenient lap. After this begin the processes which are necessary to build it into a continuous thread. Some of the most interesting problems of cotton manufacture are involved in these processes.

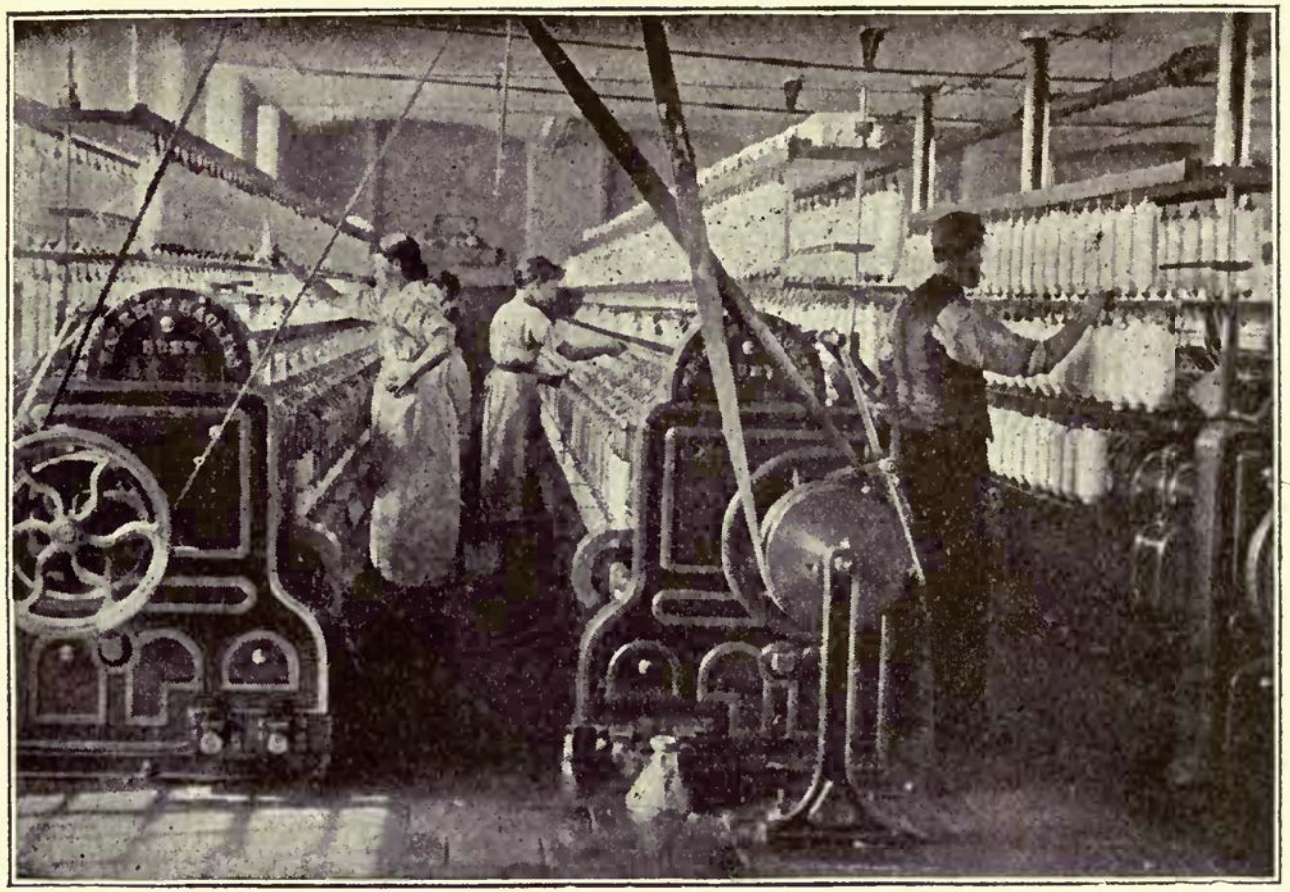
The carding engine, where the first constructive process begins, gives a final cleaning to the cotton, lays the fibres parallel to each other, and forms them into a sliver or rope. The last two operations are of the first importance, since any defective work here will influence the remaining processes and persist in the final yarn. Perfection is impossible, of course, but the good cotton spinner aims at being as near to it as possible. The obstacles in the way of securing perfection in yarn are innumerable ; irregularity may be produced by the machinery, by careless working, by defective selection, by a host of things ; and, were all the mechanics and human operations perfect, there is the variation which Nature herself insists on in giving difference of strength and diameter to the cotton fibres in all the grades. When everything possible has been done with the aid of the many devices there are for producing regularity, there remains a residuum of defect, of no practical importance perhaps, in the finished article. One of the latest cotton-trade inventions, which has not yet found its way into general use, is a device aiming at remedying some of the early defects by producing an exact parallelisation of the fibres in the early stages of spinning. The benefits are stated to be a stronger and rounder thread, less waste, and a greater receptivity to good finish.

Of the several types of carding machines now in use the revolving flat carding engine is most often found.



FRAME ROOM.

This wonderful machine has a main cylinder of 50 ins. diameter, over part of the upper surface of which travels a revolving lattice having 110 flats or metal strips. Both the cylinder and the flats have steel wire points projecting from them, the space between those on the cylinder and those on the flats being a matter of nice adjustment. The cylinder travels in the same direction as, but at a much quicker rate than, the flats. A series of feed-rollers brings the cotton from the lap to the cylinder, where the teeth on the cylinder and those on the more slowly travelling flats seize it and drag it through a combing process. Each flat, after leaving contact with the cylinder, is stripped of the fibres or refuse by a vibrating comb and a revolving brush, while the carded cotton on the cylinder is stripped from it by a doffing cylinder half the diameter of the main cylinder whose teeth face those of the carding cylinder. They are on a wire cover, and after it is struck from the wire of the doffing cylinder by an oscillating comb the cotton, now a sort of filmy web the width of the machine, is collected through guides into a sliver half an inch thick which coils in a tall can. It will be seen that between the two cylinders the cotton receives another combing. Cotton for higher counts of yarn passes through the process specifically known as combing, a further step in carding directed principally to extracting fibres which are not of the proper length : a process which involves the making of a fresh but narrower lap from the sliver. After the carding process is completed the slivers pass to the drawing frame, where they are drawn through four successive pairs of rollers which revolve at different speeds, and six to eight of the slivers are formed into one. The sliver is elongated in this way three or four times, and in the process of elongation the parallelisation of the fibres and the



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ROVING.

evenness of the sliver are improved. It will be observed that if in each of these drawing operations six slivers have been joined together, the sliver after the third operation is 216 times the length of the original sliver. It should be noted that delicate calculations accompany these operations. The delivery of material to the machines right on from scutching is adjusted according to the count of yarn it is intended to produce.

A new element enters when the elongated sliver passes on to the slubbing frame, for here comes in the use of spindles and the imparting of twist to the sliver. The intermediate and roving frames follow. In the latter, two frames and two slivers are united, so that on emerging from a roving frame the sliver is at least 864 times the length of the original carded sliver. But, of course, the number of frames used varies according to whether the yarns are to be fine or coarse. The spindles in these machines have the revolving flyer, and in addition to receiving twist the sliver is now wound on to a bobbin on the spindle. On passing this stage, the cotton is ready for the spinner : it has, by the many early processes, been made suitable raw material for the mule or ring frame. As has been shown, these two types of spinning machines are distinctive and have their separate qualities. The mule is supreme in the domain of fine spinning. Though warp may be spun on ring frames, they are mainly useful for weft. Elsewhere the mule has been dealt with, and here one need add only a few general facts. Unlike ring spinning, that on the mule is not, in normal times, done by women. It is regarded as purely a man's job. Mules having each about 100 dozen spindles are usually run in pairs, staffed normally by a minder, big piecer and little piecer. These piecers join any broken ends that appear, and carry out such duties as keeping the mules free from

an accumulation of waste. The carriage of the mule travels with its spindles over a stretch of 64 ins. and in a pair, one carriage travels inwards while the other travels outwards. Both in the mule and the ring frame the rovings pass at first through what are known as draft rollers—the separate pairs of rollers moving at different speeds in order to stretch the thread—but the principles on which the ring frame and the mule accomplish the spinning of the yarn are different. The carriage of the mule, and the mechanism by which it is made to travel in and out from the roller beam with its spindles rotating, are wonderful and ingenious, but must be seen to be understood. In the mule the spindle itself is a relatively simple structure, but in the ring frame it is more complicated. But the chief differences and the most important ones to the non-expert between the two types of spinning machines are those which have been emphasised in discussing fine and coarse spinning.

The spinning-mill as a building and as a workshop has undergone some changes of recent years. It is not now thought that good architecture and proportion in the structures is negligible. The modern mill is roomy, airy, well planned, healthy for the workpeople, and generally has architectural features which save it from being an eyesore as were many of the old mills. New spinning mills are, as a rule, much larger than their predecessors, 100,000 spindles being regarded as a suitable equipment. In other countries, generally speaking, mills are not so large as this : in the United States it is not often one finds a mill with more than 50,000 spindles. A mule mill requires to be larger for a given number of spindles than a ring-frame mill, and because of this fact, coupled with the high cost of building, it will not be surprising if in places where the

spinning is of the lower counts we find in future some conversions from mule to ring spinning. One or two firms in the first two years of peace did embark on projects of this kind. But no great movement along this line is likely to be seen, since, as has been emphasised earlier in this book, British spinning is tending to finer productions.

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